

# Sustainable Food and Agriculture Strategy in Kulon Progo Regency based on SWOT and Spatial Analysis

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## ABSTRACT

Changes in the use of agricultural land to non-agriculture are threats to food security. For this reason, a strategy is needed so that food agriculture in a region can be sustainable. This research aims to make recommendations for sustainable food and agriculture (SFA) policy strategies in Kulon Progo Regency. Strengths-Weaknesses-Opportunities-Threats (SWOT) and spatial analysis were used to formulate a sustainable food and agriculture policy strategy. The results of the research include recommendations for sustainable agriculture strategies for Kulon Progo Regency, including the integrated rice fields protection with regional spatial plans (RSP), fostering farmer groups, rice fields fair and balanced control, land conservation development, intensive mechanisms development, new rice fields printing, productive workforce absorption, changing patterns of housing needs, and initiation of agriculture as a prestigious business field. The strategy of SFA spatially is divided into three clusters, which are avoiding land conversion, printing new rice fields with land conservation methods and construction of irrigation canals, and intensifying rice farming by utilizing agricultural technology.

**Keywords:** Sustainable food, Sustainable agriculture, Food security, SWOT analysis, Spatial analysis.

## 1. INTRODUCTION

The idea of sustainable agriculture is part of Agenda 21, an action program for sustainable development discussed by 109 world leaders at the Rio Conference in Brazil in 1992. The concept and program are contained in chapter 14, entitled Promoting Sustainable Agriculture and Rural Development [1]. What is meant by sustainability is keeping something alive and preventing it from shrinking, thus agricultural sustainability means efforts in agriculture to remain productive and maintain agricultural resources [2].

Sustainable agriculture is agriculture that leads to agricultural profitability, the life quality improvement of farming families, rural community vitality, and environmental protection. The sustainable agriculture movement has developed in the last three decades to solve conventional farming systems and social problems. Sustainable agriculture is gaining support because it provides economic opportunities and innovation for

farmers, policymakers, and others in the food system [3]. Agricultural development has a strategic role in the national economy, including as a provider of food, feed, industry, bioenergy, employment, sources of income for the community and the state, and environmental conservationists. Indonesia's agricultural development is expected to become sustainable agriculture as the sustainable development implementation (SDGs). The sustainable agriculture concept includes three things: economic sustainability, population life sustainability, and environmental sustainability [1]. Sustainable agriculture aims to balance the economic, environmental, and social aspects of agriculture and to create an agricultural system resilient in the long term [4].

Sustainable agriculture faces the challenge of land-use change. Changes in the use of agricultural land to non-agriculture are threats to food security. Therefore, it is necessary to save agricultural land [5]. One of the rescue efforts carried out by the Indonesian government is the enactment of Law Number 41 of 2009 [6]

concerning the sustainable food and agriculture Land Protection (LP2B). LP2B is agricultural food land determined to be protected and developed consistently to produce staple food for regional food self-reliance and security. The law aims to maintain the area of agricultural land so that there is no change in land use to non-agriculture.

In addition to maintaining the area of agricultural land, various strategies are needed to realize sustainable agriculture. The existence of mechanization in agriculture led to an increase in productivity. However, since the 1960s, this increase has led to environmental degradation [4]. Therefore, agricultural intensification strategies require diverse and specific solutions. One solution is an agroecological approach that allows lower production to be a solution to realize sustainable agriculture [7]. Another solution is Integrated Farm Management (IFM), an integrated farm management that involves modern technology use and traditional methods. Integrated agriculture is designed to maintain productivity while improving the environment [4]. However, sustainable agricultural strategies need to be adapted to the conditions of each region.

Changes in agricultural land use to non-agricultural use occur evenly in Indonesia, including in Kulon Progo Regency, Special Region of Yogyakarta. This district has experienced massive transportation infrastructure development, one of which is Yogyakarta International Airport (YIA) which began in 2017. YIA development requires 600 ha areas, most of which comes from the conversion of rice fields. This causes a decrease in the rice field areas, especially in the Temon District. The development of transportation infrastructure accelerates the urbanization process, changes the socio-economic structure of the community, and leads to the reduction of agricultural land [8].

Sustainable agriculture in a region needs a strategy to deal with changes in agricultural land-use due to regional development, transportation, and infrastructure. A strategy analysis that is widely used is the Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis. SWOT is an analytical tool that is quite effective and efficient in formulating regional development program strategies [9].

A study on an agricultural development program in Kulon Progo Regency by Rozaki et al. [10] using location quotient analysis based on potential regional has result recommendations for agricultural development programs could improve the quality of human resources, organizations, and facilities. Andriawan et al. [11] conducted a spatial study of the protection strategy of rice fields by mapping the suitability of the potential LP2B in Magelang City. The result shows that of the total rice field area of 215.817 ha and 52.68% are very potential and 41.7% can be used as LP2B.

In fact, research that examines sustainable food and agriculture applying SWOT and spatial analysis based on LP2B is still limited. Therefore, a SWOT analysis is needed to create a sustainable food and agriculture strategy in general and a spatial analysis to recommend a sustainable food and agriculture strategy in particular.

In this research, the authors first formulated a sustainable food and agriculture strategy using SWOT analysis. Second, the authors determined the potential of each region to become a sustainable food and agriculture area. Furthermore, the results were applied as the basis for making a spatially sustainable agricultural strategy. Through this research, sustainable food and agriculture strategies can promote the second goal of the Sustainable Development Goals (SDGs), which is to achieve food security through sustainable agriculture.

## 2. METHOD

This research used secondary data from Kulon Progo Regency by applying qualitative and quantitative methods. Qualitative approach was carried out through SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis, while the quantitative approach was carried out through spatial analysis. SWOT analysis principle uses the strength points to take advantage of opportunities (SO), overcome weaknesses to take advantage of opportunities (WO), use strengths to deal with threats (ST), and overcome weaknesses to avoid threats (WT). The analysis was done by creating SWOT matrix as shown in the Table. 1.

The strategy of spatially sustainable agriculture was carried out by distinguishing the potential between regions. This was done based on the SWOT result strategy, the sustainable food and agriculture land protection (LP2B), and the distribution of rice fields. The determination of the LP2B area was carried out using an overlay technique using QGIS on rice field data, including land area, land conversion rate, productivity, carrying capacity, and type of irrigation. Variable criteria, scores, and weights can be seen in Table 2.

Each variable score was multiplied by the weight which in the end produced the total score. The total score became the reference for determining LP2B which contained three priority classes, namely high ( $\geq 27$ ), medium (21-26), and low ( $\leq 20$ ).

## 3. RESULTS AND DISCUSSION

### 3.1. Sustainable Agriculture

The allotted agricultural area consists of areas designated for agriculture for food crops, horticulture, plantations, and livestock. The designated areas for food crop agriculture consist of wetland agriculture and dryland agriculture. The area designated for wetland

agriculture in Kulon Progo Regency is 10,622 ha, while the allotment for dryland agriculture is 29,328 ha spread across all sub-districts [12]. In this research, a sustainable agriculture study was dedicated to wetland food agriculture. This type of agriculture is in the form of rice fields with food production, namely rice.

Sustainable agriculture is the ability to stay productive while maintaining basic resources. Agricultural development is an effort to increase the capacity and culture of the community to increase capacity, quality, professionalism, and productivity so that they can dynamically take advantage of opportunities and overcome all forms of threats, challenges, obstacles, and disturbances [2].

**Table 1.** Matriks SWOT

|  | <b>Internal</b> | <b>Strengths</b>  |  | <b>Weaknesses</b>   |
|--|-----------------|---|--|---|
| <b>Eksternal</b>   |                 | <ul style="list-style-type: none"> <li>Strength list</li> </ul> |  | <ul style="list-style-type: none"> <li>Weakness list</li> </ul> |
| <b>Opportunities</b>   |                 | Strengths-Opportunities (SO) Strategy                           |  | Weaknesses-Opportunities (WO) Strategy                          |
| <ul style="list-style-type: none"> <li>Opportunity list</li> </ul> |                 |   |  |   |
| <b>Threats</b>   |                 | Strengths-Threats (ST) Strategy                                 |  | Weaknesses-Threats (WT) Strategy                                |
| <ul style="list-style-type: none"> <li>Threat list</li> </ul>      |                 |   |  |   |

Source: [9]

**Tabel 2.** The determination of the LP2B

| <b>Variable criteria</b>   | <b>Scores</b> | <b>Weight</b> |
|--|---------------|---------------|
| Rice field area  |               |               |
| <ul style="list-style-type: none"> <li>More than 5 ha</li> </ul>                   | 2             | 1             |
| <ul style="list-style-type: none"> <li>Less than 5 ha</li> </ul>                   | 1             |               |
| Land conversion rate   |               |               |
| <ul style="list-style-type: none"> <li>Positive</li> </ul>                         | 2             | 2             |
| <ul style="list-style-type: none"> <li>Negative</li> </ul>                         | 1             |               |
| Productivity   |               |               |
| <ul style="list-style-type: none"> <li>More than 5 ton/ha</li> </ul>               | 2             | 3             |
| <ul style="list-style-type: none"> <li>Less than 5 ton/ha</li> </ul>               | 1             |               |
| Carrying capacity of rice  |               |               |
| <ul style="list-style-type: none"> <li>CCr <math>\geq 2</math></li> </ul>          | 3             | 4             |
| <ul style="list-style-type: none"> <li>CCr <math>\geq 1 - &lt; 2</math></li> </ul> | 2             |               |
| <ul style="list-style-type: none"> <li>CCr <math>&lt; 1</math></li> </ul>          | 1             |               |
| Type of irrigation   |               |               |
| <ul style="list-style-type: none"> <li>Irrigation</li> </ul>                       | 2             | 5             |
| <ul style="list-style-type: none"> <li>Rainfed</li> </ul>                          | 1             |               |

Source: [13]; [14]

Sustainable food and agriculture (SFA) needs to be done given the increasing demand for food availability along with the growing population. As a direct consequence of population growth, there is a greater demand for food, fiber, water, and energy. The increase in consumption puts pressure on existing natural resources which poses a tremendous challenge for mankind, namely responding to the demands of a

growing society without compromising environmental sustainability [15].

Protection of sustainable food and agricultural land is one of the government's policies to realize food sovereignty. According to the Ministry of Agriculture Regulation No. 7 of 2012, agricultural land that will be used as LP2B is a land that produces staple food crops

(paddy) that meet the community's food (rice) needs based on the average productivity level of agricultural land and population.

### 3.2. Sustainable Agriculture Strategy

#### 3.2.1. SWOT Analysis

The strategy for sustainable food and agriculture in Kulon Progo Regency was prepared using a qualitative SWOT analysis method. The SWOT analysis began with creating a matrix of internal factors (Strengths-Weaknesses) and external factors (Opportunities-

Threats) related to sustainable food and agriculture. External and internal factors of sustainable food and agriculture strategy in this research considered changes in land use, food agriculture carrying capacity, and other relevant factors. The changes in land use in question is an increase in rice fields and built-up land. The carrying capacity of food agriculture includes a good carrying capacity of rice food, a high rice field productivity, and an increase in population. The matrix of internal and external factors and strategies for sustainable food and agriculture in Kulon Progo Regency can be seen in Table 3.

**Table 3.** SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis

|  |  |   |
|--|--|---|
| <b>Internal factors</b>  | <b>Strengths (S)</b><br>1. Food agriculture carrying capacity is good<br>2. Rice field expansion<br>3. High productivity of rice fields<br>4. The existence of farmer groups   | <b>Weaknesses (W)</b><br>1. Dominant rice fields less than 5 ha<br>2. The relief of the western part of Kulon Progo Regency in the form of hills (Menoreh Hill)<br>3. In general, the age of farmers who are relatively old with a low level of education   |
| <b>External factors</b>  |  |   |
| <b>Opportunities (O)</b><br>1. Sustainable food and agriculture land protection (LP2B)<br>2. Improved control over space utilization and integration of LP2B into regional spatial plan (RTRW).<br>3. Agricultural technology        | <b>SO Strategy</b><br>1. Limiting the conversion of rice fields that have high carrying capacity and productivity and vice versa, directions for land in less productive areas that are integrated with the regional spatial plan (RTRW). (S1, S2, S3, O1, O2)<br>2. Fostering farmer groups for the purpose of increasing land productivity by utilizing agricultural technology in the process of planting, maintaining, harvesting, processing, and marketing. (S4, O4) | <b>WO Strategy</b><br>3. Distributing land tenure in such a way as to fulfill the basic needs of all community members and their rights in land use. (W1, O1)<br>4. Developing intensive mechanisms to encourage farmers to maintain their agricultural land through the development of agricultural infrastructure, tax relief, and ease of obtaining superior seeds and fertilizers, especially in LP2B. (W2, O3)<br>5. Developing intensive mechanisms to encourage farmers to maintain their agricultural land through the development of agricultural infrastructure, tax relief, and ease of obtaining superior seeds and fertilizers, especially in LP2B. (W3, O1, O2) |
| <b>Threats (T)</b><br>1. Improved built-up area<br>2. Airport construction and aeropolis area development<br>3. Population growth<br>4. The shift of the young workforce from the agricultural sector to the non-agricultural sector | <b>ST Strategy</b><br>6. Replacing converted rice fields by producing new rice fields in areas with high carrying capacity and agricultural productivity and/or additional rice field area of less than 5 ha. (S1, S2, S3, T1, T2)<br>7. Absorbing and transferring productive labors as a means of equitable distribution and improvement of welfare through institutions and farmer groups. (S4, T3, T4)   | <b>WT Strategy</b><br>8. Changing people's lifestyles in terms of fulfilling the need for housing by developing flats so that the need for land for housing can be reduced. (W1, T3)<br>9. Directing and promoting agriculture as a prestigious business field to attract the interest of young workforce. (W3, T4)   |

The SWOT analysis in Table 3 resulted in nine recommendations for sustainable food and agriculture strategies in Kulon Progo Regency. These recommendations are as follows:

1. limiting the conversion of rice fields that have high carrying capacity and productivity and vice versa, directions for land in less productive areas that are integrated with the regional spatial plan (RTRW);
2. fostering farmer groups for the purpose of increasing land productivity by utilizing agricultural technology in the process of planting, maintaining, harvesting, processing, and marketing;
3. distributing land tenure in such a way as to fulfill the basic needs of all community members and their rights in land use;
4. developing mechanical (creating terraces on sloping land) and chemical (adding chemicals as soil stabilizers so that the soil can be resistant to erosion) land conservation;
5. developing intensive mechanisms to encourage farmers to maintain their agricultural land through the development of agricultural infrastructure, tax relief, and ease of obtaining superior seeds and fertilizers, especially in LP2B;
6. replacing converted rice fields by producing new rice fields in areas with high carrying capacity and agricultural productivity and/or additional rice field area of less than 5 ha;
7. absorbing and transferring productive labors as a means of equitable distribution and improvement of welfare through institutions and farmer groups;
8. changing people's lifestyles in terms of fulfilling the need for housing by developing flats so that the need for land for housing can be reduced; and
9. directing and promoting agriculture as a prestigious business field to attract the interest of young workforce.

Sustainable food and agriculture strategies as the SWOT analysis result can be described as follows. The first and second strategies are strengths-opportunities (SO), which are progressive strategies designed to use strengths to take advantage of opportunities. The elaboration of the first strategy can be done by utilizing increased carrying capacity, increasing land area, and developing rice field productivity to be used as sustainable food and agricultural land. Recommendations for sustainable food and agriculture areas can be seen in Figure 1a. The second strategy can be done by increasing assistance, providing agricultural technical assistance, and counseling to farmer groups to utilize technology in agricultural businesses.

The third, fourth, and fifth strategies are weaknesses-opportunities (WO), namely strategies prepared by minimizing weaknesses to take advantage of opportunities. The weaknesses identified were the rice fields fragmentation with less than 5 ha area due to obstacles to clearing rice fields in the northwest

(Menoreh Hills) and the low education of elderly farmers. Government policies can be used to maintain rice fields' existence and agricultural technology to develop agricultural productivity to improve the farmers' welfare.

The sixth and seventh strategies are strengths-threats (ST), strategies that use strengths to overcome threats. The identified threats are the increase in built-up land, the construction of an airport as part of the aero polis area development plan, and the low regeneration of farmers. For this reason, areas that have rice fields with high carrying capacity and productivity can be a location for printing rice fields to replace converted rice fields. Furthermore, the formation of certain institutions or agencies consisting of farmer, youth, and the government can be a solution for agricultural activities and the protection of rice fields.

The eighth and ninth strategies are weaknesses-threats (WT) strategies. WT strategy is a defensive strategy done by minimizing weaknesses to avoid threats. Weaknesses related to threats are population growth and low farmer regeneration. Strategies that can be done to avoid the threat of decreasing rice fields are to change the pattern of housing needs with a minimalist form or flats and increase farmers welfare to attract the young workforce to be involved in agricultural businesses.

### 3.2.2. Spatial Analysis

The sustainable food and agriculture strategy as a result of the SWOT analysis was then used to formulate a sustainable agricultural policy strategy for each sub-district in Kulon Progo using spatial analysis. In formulating spatially sustainable food and agriculture strategies, it is necessary to identify the potential of each region. Food agricultural land in an area cannot directly be determined as LP2B. There are LP2B criteria that have been determined in government policies, such as Law No. 41 of 2009, Government Regulation No. 1 of 2011, and Minister of Agriculture No. 7 of 2012. The criteria include land area units, land suitability, basic infrastructure, and land use as food crops.

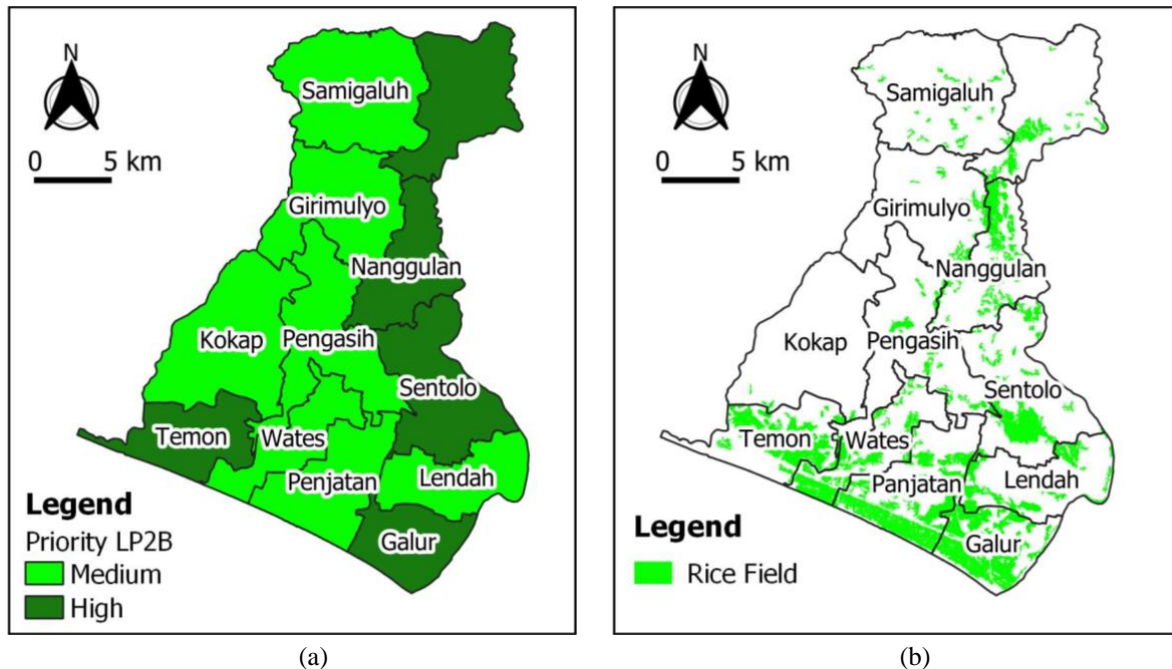
The assessment result of the rice fields potential based on the predetermined LP2B variables can be seen in Table 4. The value in the table is the average (aggregate) score of lowland agricultural lands on the LP2B variables in the district analysis unit. Meanwhile, the value in the total score column is the average of the sum and weighting of each rice field polygon score against the LP2B variable in each sub-district. The average value of the total score becomes a value that represents the potential for determining LP2B for rice fields based on sub-districts.

A sub-district with a total score of 27 indicates that it has a high potential for LP2B protection. According to this research results, the five sub-districts fall into this category. Meanwhile, other sub-districts are in the moderate category (21–26). It shows that all sub-districts

in this research area can be designated as LP2B areas. The distribution of potential LP2B areas in this research area is shown in Figure 1a, while the distribution of rice fields is shown in Figure 1b.

This research found that subdistricts in Kulon Progo have the potential for sustainable agricultural land, which

are divided into two categories, namely high and medium, while the low category does not exist. In this regard, the research results of Rozaki et al [10] show that there are only six subdistricts with rice fields that have the potential to be developed, namely Galur, Nanggulan, Panjatan, Samigaluh, Temon, and Wates.



**Figure 1.** Sustainable agricultural policy strategy in Kulon Progo using spatial analysis (a) Two levels of potential areas, high and medium, for sustainable food and agriculture based on subdistricts in Kulon Progo Regency. (b) Distribution of rice fields with an area of >5 ha is a priority to be used as LP2B.

The subdistricts with high potential for rice fields to be considered as LP2B are Temon, Galur, Sentolo, Nanggulan, and Kalibawang. All rice fields in these subdistricts are irrigated rice fields, except for a small portion of rice fields in Temon (82 ha of 1154 ha) and Sentolo (81 ha out of 1,318 ha) subdistricts which are rainfed. The expanse of rice fields is relatively wide in each subdistrict. The relatively high productivity of rice fields is reflected by the good food carrying capacity. The rate of conversion of rice fields in Temon, Galur, and Sentolo is positive, but in Nanggulan and Kalibawang is negative. Temon, Galur, and Sentolo have very high scores (30) to be prioritized as LP2B areas.

The subdistricts with moderate potential to be considered as LP2B are Wates, Panjatan, Girimulyo, Pengasih, Lendah, Kokap, and Samigaluh. The type of irrigation for rice fields in these areas are dominated by irrigation, but there are also large rainfed rice fields such as in Samigaluh and Lendah. The productivity of rice fields is relatively high, but the carrying capacity of food is not good. This is due to the high demand for food due to population growth. The rate of conversion of rice fields in these subdistricts is positive, except in Samigaluh which is negative (depreciated).

The strategy of spatially sustainable food and agriculture can be elaborated as follows. Nanggulan, Temon, Galur, Kalibawang, and Sentolo have good food carrying capacity and high LP2B potential, so it is necessary to limit the conversion of rice fields through space utilization control policies. Samigaluh, which is experiencing a decrease in rice fields and an increase in built-up area, requires the development of an intensive mechanism to encourage farmers to maintain their rice fields. In addition to supporting the agricultural process, the construction of irrigation canals also encourages the creation of new rice fields due to the availability of water.

Wates as the capital of Kulon Progo Regency and Panjatan that is located next to Wates have large rice fields, so these areas need to be maintained by changing the pattern of land requirements for settlements with flat/minimalist forms. Pengasih and Lendah with rice fields that are not too wide require optimizing the potential of rice fields by using agricultural technology to increase food production. Meanwhile, farmers in Kokap and Girimulyo who have small rice fields due to hilly morphology require assistance through farmer groups to develop land conservation both mechanically and chemically.

#### 4. CONCLUSION

According to the SWOT analysis, the sustainable food and agriculture strategy in Kulon Progo Regency can be formulated by integrating rice fields protection with the RSP, fostering farmer groups, controlling rice fields in a fair and balanced manner, developing land conservation, developing intensive mechanisms, printing new rice fields, empowering productive workers, changing the housing needs pattern, and making agriculture as a prestigious business field. Meanwhile, the spatially sustainable food and agriculture strategy was formulated by preventing the rice fields conversion (in Nanggulan, Temon, Galur, Kalibawang, and Sentolo sub-districts), creating new rice fields using land conservation methods and irrigation canals construction (in Kokap, Girimulyo, and Samigaluh), and conducting intensification of rice field agriculture by utilizing agricultural technology (in Wates, Panjatan, Pengasih, and Lendah).

#### AUTHORS' CONTRIBUTIONS

**Irwansyah Sukri:** Analyzed and interpreted the data, field survey, writing – original draft, writing – review & editing. **Rika Harini:** Conceived and designed, Writing – review & editing, Supervision, Funding acquisition. **Sudrajat:** Conceptualization, Methodology, Supervision.

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