Strategy for increasing lowland rice productivity in West Java Province with the SWOT-AHP model approach

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Abstract. The high production and consumption of rice in Indonesia show that rice commodities are not the only concern of producers’ interests but also consumers’ needs. If there is a rice crisis, there will be a food crisis that will affect other social problems. West Java has great potential to become a center for rice production in Indonesia. This study uses a combined method called Analytical Hierarchy Process (AHP) and SWOT Analysis - AHP. The results of the study indicate that the role of Gapoktan and farmer regeneration are very important consideration factors for the development of lowland rice commodities in West Java. In this case study, it was proven that the combination of SWOT and AHP methods can be used to measure the priority of factors in the SWOT analysis.

Keywords: analytical hierarchy process, optimization of gapoktan, young farmers, rice productivity, SWOT-AHP

1. Introduction

Rice is one of the most important commodities for Indonesia. Rice consumption in Indonesia every year is increasing along with the increasing population. The high dependence of the Indonesian people for rice is a problem if the availability of rice is not sufficient, thus it can disrupt national food security. The high production and consumption of rice in Indonesia shows that rice commodities are not the only concern of producers’ interests, but also the consumers’ needs. In the case of a rice crisis, a food crisis will occur. The rice crisis triggered a chain crisis such as a nutritional crisis, health crisis, economic, social and political crisis [1, 2].

According to the Ministry of Agriculture, West Java as one of the centers of rice production has great potential to become the largest rice production center in Indonesia, beyond East Java. The province of West Java borders the Java Sea in the north, Central Java in the east, the Indian Ocean in the south, and Banten and DKI Jakarta in the west. The northern coast of West Java region is lowland. In the middle part is a mountain, which is part of a mountain range that stretches from the west to the east of Java. The population of West Java Province is as many as 43,053,732 people includes those who live in urban areas as many as 28,282,915 people (65.69%) and in rural areas as many as 14,770,817 people (34.31%). For the past 30 years, West Java Province accounted for 22% of national rice production with 95% of rice produced from paddy fields and the other 5% produced from dry land [3].

The West Java Office of Industry and Trade said that the correction of estimates of rice production reported by the Central Statistics Agency (BPS) placed the calculation of the 2018 West Java rice
production as a deficit. The reason is that land area increases and productivity per hectare decrease, while consumption per person of rice increases which results in deficit rice production. Rice productivity shows fluctuation with the increasing value within 2014-2015 and the decreasing value occurred from 2015-2018 with only slight increase of growth (0.07%) from 2017-2018. Highest rice productivity in West Java happened in 2015 with 61.22 Ku/ha. Moreover, the area of paddy farming in West Java continues to increase every year, with the growth in land area increase between 2018 and 2017 at 1.52% [4].

Productivity can be indicated from the ratio of production to the use of total production factors. Factors that affect productivity include land quality, labor, new seeds/varieties, fertilizers, agricultural technology innovations, and agricultural technology adoption [5]. The success of new varieties is strongly influenced by the ability to produce and adoption by farmers. The decline in the growth rate of wetland rice production is caused by a decrease in the rate of growth in harvest area and land productivity. During 1978-1998, around 1.07 million ha of land (30.8%) had been converted to non-agricultural land. During the same period, there were about 0.91 million ha of new rice fields being opened. If the area of land increases but the productivity of rice decreases, there are several factors that influence this situation, consists of the low level of technology adoption, the acceptance of new varieties that have environmental productivity and adaptation, a decrease in farm quality, and land quality such as land exhaustion. In the Asian region, the symptoms of land fatigue have caused the growth rate of productivity of lowland rice to slow down or even decline, especially in areas that have historically been the target locations of rice intensification programs which are usually the centers of rice production in the country involved [6, 7].

The role of youth is very important as the next generation for the sustainability of the agricultural sector, but the phenomenon that currently occurs is that young farmers are reluctant to work in agriculture so that the number of young farmers is decreasing, whereas the number of old farmers is increasing. Various reasons for the decline in the interest of young workers in the agricultural sector is mainly the image of the less prestigious in the agricultural sector and the lack of adequate compensation. For young people in rural areas, the agricultural sector is increasingly losing its appeal due to the influence of the digital era as it is now. The crisis of young farmers in the agricultural sector and the predominance of old farmers have consequences for the development of a sustainable agricultural sector, especially on agricultural productivity, market competitiveness, rural economic capacity, and further, it will threaten food security and the sustainability of the agricultural sector [5].

2. Problem statement

Problems are identified by looking for gaps between the current situation and the ideal situation being targeted. The existing problems are divided into 5 aspects, namely Technology, Economy, Social, Environment and Policy as found in figure 1. It takes a deep understanding of the factors that influence the development of commodity rice fields to improve the effectiveness of strategies and policies taken in an effort to increase production.

![Figure 1. Problem diagram area.](image-url)
3. Research methods

This study uses a combined method called Analytical Hierarchy Process (AHP) and SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats) - AHP. The initial AHP is used to compress the problems that will be solved. In this study, we use the AHP for prioritization of SWOT elements. Once the problem has been decomposed and the hierarchy is constructed, prioritization procedure starts in order to determine the relative importance of the criteria. In each level, the criteria are compared pairwise according to their levels of influence and based on the specified criteria in the higher level. In AHP, multiple pairwise comparisons are based on a standardized Saaty comparison scale. The SWOT analysis identifies Strengths, Weaknesses, Opportunities, and Threats faced. Strengths and weaknesses are identified through an assessment of the internal environment, while opportunities and threats are known through an assessment of the external environment. If used correctly, SWOT can be a good basis for successful planning and policy formulation. But in the conventional SWOT analysis, the relative importance of various factors is not quantified and is very subjective. Therefore, the importance of each factor in the proposed plan or policy is unknown. By looking at the strengths owned and developing these strengths, it is certain that rice farming will be more advanced than before. Likewise, the weaknesses must be corrected so that rice farming in West Java can still exist. Existing opportunities must be best utilized by farmers so that the volume of rice production can increase. The threats that will be faced by farmers must be faced by developing a good marketing strategy [8, 9, 10, 11]. However, this deficiency can be overcome if SWOT is combined with the Analytical Hierarchy Process (AHP) to become a SWOT – AHP. The AHP-SWOT methodology hierarchy consists of four levels. The first level is the goal of strategy formulation, the second level is four groups of factors defined by the SWOT technique, the third level is the strategic factors included in each factor group defined by the SWOT technique, the fourth level is the strategy that must be evaluated and compared [12, 13].

The problems that have been identified are then analyzed using the method and results in the research scheme is shown in figure 2 below.

![Figure 2. Thinking framework for conducting case studies.](image)

The problems that have been identified are formulated into 5 aspects, then AHP can be applied to find out the big picture of the solutions and policies that will be applied to solve the problem. Problems that have been recorded are grouped based on internal and external factors to facilitate SWOT grouping. Furthermore, the implementation of the SWOT-AHP is carried out to analyze the SWOT from the big picture of the solution to be implemented so that an appropriate and effective strategy can be designed based on the details of the superior factors in each SWOT.

4. Results and discussion

The problems that have been identified are analyzed using the AHP model to determine solutions and prioritize solutions to problems using Saaty’s comparison scale [8, 14]. The execution of cases based on the AHP method is divided into 3 levels, namely level 1 (category), level 2 (parameter), and level 3 (general description of the solution applied). Level 1 divides the total problems related to existing
productivity (16 problems which are then narrowed down into 11 problems) into 5 aspects, consist of technology, economy, social, environment, and policy. Problems that are in the aspect category are then classified into several parameters, which aim as the point or criteria for determining success for each category. Furthermore, at level 3 there are 7 general descriptions of the proposed solutions along with their relationship with the parameters that are able to realize the solution. The AHP model diagram is shown in figure 3. AHP modeling aims to choose a description of the solution in general which is the main focus in the following case studies based on logical weighting. Weighting is carried out between categories and between parameters/factors to see the final results in the form of aspects and factors that are the top priority in the direction of completion of case studies and priority solutions to be applied and further developed in the form of strategies, policies, and programs. The AHP model also formulates the priorities of each factor using the Expert Choice ver. 11 application and the results are shown in table 1.

The priority of the AHP component in table 1 shows that the social aspect has the highest priority with a value of 0.471, followed by the technological aspect of 0.268 and the economic aspect of 0.143. The entire aspect has a range of consistency ratios below 10% so that the weighting results can be assumed to run well and consistently. The final priority value of each factor is obtained by multiplying the priority value of the aspect with the priority value of the factor. The final results obtained indicate that the factor "Improving the quality of farmer HR" from the social aspect is the factor with the highest priority (0.404), followed by the factor "Increasing the quantity of rice" from the technological aspect (0.214) and "Optimizing funding assistance" from the government economy (0.123).

Alternative solutions chosen in this study and priority values, consist of 'Training and extension of farmers in gapoktan' (0.214), 'Young farmer cadre' (0.206), and 'Use of rice production technology' (0.194). The results obtained are then processed further to determine the direction of the formation of strategies, policies, and programs to overcome the problems of rice productivity. Based on the priority results of productivity case resolution solutions obtained through AHP, the direction of developing strategies, policies, and programs is obtained based on the two highest aspects with priority values above 0.100, namely social and technology. Furthermore, the direction of the solution was further identified by the important factors in determining the productivity of wetland rice in West Java based on strengths, weaknesses, opportunities, and threats shown in table 2. SWOT-AHP modeling is used to find out the direction of parameters that are of higher priority to assist in determining the direction of strategy development. The SWOT-AHP model is shown in figure 4. Meanwhile, the SWOT diagram of the four aspects is shown in figure 5.

Table 1. Aspect probability and problem factors.

| Aspect Group | Priority of the group | Aspect Factors | Consistency ratio (%) | Priority of the Factor within the group | Overall priority of the factor |
|--------------|-----------------------|----------------|-----------------------|----------------------------------------|-------------------------------|
| Technology   | 0.268                 | Increased quantity of rice | 7 | 0.800 | 0.214 |
|              |                       | Increased quality of rice  | 7 | 0.200 | 0.054 |
| Economy      | 0.143                 | Decreased in production costs | 8 | 0.143 | 0.020 |
|              |                       | Optimizing funding aid from the government | 8 | 0.857 | 0.123 |
| Social       | 0.471                 | Optimization of farmer groups | 3 | 0.143 | 0.067 |
|              |                       | Human resources quality improvement for farmers | 3 | 0.857 | 0.404 |
| Environment  | 0.044                 | Increased land productivity | 7 | 0.167 | 0.007 |
|              |                       | Sustainable land management | 7 | 0.833 | 0.037 |
| Policy       | 0.075                 | The government's active role in Gapoktan | 7 | 0.125 | 0.009 |
|              |                       | Application of research results | 7 | 0.875 | 0.066 |
Figure 3. AHP model.

Figure 4. SWOT-AHP model.
Table 2. West Java rice productivity SWOT analysis.

| S       | Government support for the role of Gapoktan       | S1 |
|---------|--------------------------------------------------|----|
| S       | Gapoktan institutions can strengthen the agricultural sector | S2 |
| S       | Technology infrastructure available, easy accessibility | S3 |
| W       | Lack of competency of farmers in Gapoktan, especially in preparing RDKK | W1 |
| W       | Low interest in youth in agriculture | W2 |
| W       | The lack of application of agricultural technology | W3 |
| O       | Potential absorption of labor and improvement of the village economy | O1 |
| O       | Village fund programs from the government can be used for the agricultural sector | O2 |
| O       | The number of private institutions and higher education as a center for research and technology | O3 |
| T       | The crisis of regeneration of young farmers | T1 |
| T       | Rice self-sufficiency is disrupted | T2 |
| T       | Technology gap between farmers and cooperatives | T3 |

The details for each SWOT are then crossed between internal parameters (Strengths and Weaknesses) with external parameters (Opportunities and Threats) to determine the best strategy option. The final results obtained in the form of a list of strategies based on considerations in terms of Strengths-Opportunities, Strengths-Threats, Weaknesses-Opportunities, and Weaknesses-Threats. AHP results for each SWOT are detailed in table 3.

![SWOT-AHP diagram](image)

**Figure 5.** SWOT-AHP diagram.

Table 3 shows that the Strengths have the highest priority of 0.462, followed by Opportunities of 0.301, Weaknesses of 0.134, and Threats of 0.103. The value range of the Consistency ratio of all factors is below 10% so the results of the weighting can be assumed to be running well and consistently.
Table 3. The probability of solution using SWOT.

| SWOT Group | Priority of the group | SWOT Factors                                                                 | Consistency ratio (%) | Priority of the Factor within the group | Overall priority of the factor |
|------------|-----------------------|-------------------------------------------------------------------------------|-----------------------|----------------------------------------|-------------------------------|
| Strengths  | 0.462                 | Government support for the role of Gapoktan (S1)                              | 0.160                 | 0.074                                  |                               |
|            |                       | Gapoktan institutions can strengthen the agricultural sector (S2)             | 0.168                 | 0.078                                  |                               |
|            |                       | Technology infrastructure available, easy access (S3)                        | 0.119                 | 0.055                                  |                               |
| Weaknesses | 0.134                 | Lack of competency of farmers in Gapoktan (example: preparation of RDKK) (W1)| 0.086                 | 0.012                                  |                               |
|            |                       | Low interest in youth in agriculture (W2)                                   | 0.053                 | 0.007                                  |                               |
|            |                       | The lack of application of agricultural technology (W3)                      | 0.062                 | 0.008                                  |                               |
| Opportunities | 0.301               | Potential for employment and improvement of village economy (O1)             | 0.059                 | 0.018                                  |                               |
|            |                       | The village fund program from the government can be used for the agricultural sector (O2) | 0.057                 | 0.017                                  |                               |
|            |                       | The number of private institutions and higher education institutions as research and technology centers (O3) | 0.072                 | 0.022                                  |                               |
| Threats    | 0.103                 | Young farmers' regeneration crisis (T1)                                      | 0.091                 | 0.009                                  |                               |
|            |                       | Rice self-sufficiency disrupted (T2)                                         | 0.032                 | 0.003                                  |                               |
|            |                       | Technology gap between farmers and corporations (T3)                        | 0.041                 | 0.004                                  |                               |

From the alternative solutions chosen, it will be then implemented into activities plans that can be carried out in the field along with the backup plan. But in this study, the implementation process was not carried out directly. Several planned activities that can be carried out and a backup plan if they fail are shown in table 4.

Priorities obtained indicate that the factor "Institutional gap can strengthen the agricultural sector (S2)" as the power has the highest priority value followed by factors "Number of private institutions and higher education institutions as research and technology centers (O3)" as opportunities, factors "Lack of competence farmers in Gapoktan (example: drafting RDKK) (W1) "as a weakness, and a factor of" the crisis of regenerating young farmers (T1) "as a threat. The strategy is based on consideration of these factors and produces a strategy formulation matrix presented in table 5.
### Table 4. Plan of activities and backup plans.

| No | Plan for activities                                                                 | Possibility | Backup plan                                                                 |
|----|--------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------|
| 1  | Strengthening Gapoktan institutional capacity, for example by adding production and   | If it fails | Providing guidance to independent farmer groups                             |
|    | capital facilities by utilizing the absorption of village funds                       |             |                                                                            |
| 2  | Improve optimization of the role of Gapoktan through partnership and network          | If it fails | Approach directly to stakeholders                                           |
|    | development (networking)                                                             |             |                                                                            |
| 3  | Cooperating with the application of agricultural technology through equipment         | If it fails | Looking for investors and other independent research institutions          |
|    | assistance and training cooperation with private and higher education institutions   |             |                                                                            |
| 4  | Increasing the competency of farmers in gapoktan through counseling and assistance,  | If it fails | Provide personal understanding to figures who are considered influential    |
|    | including training in the preparation of RDKK                                       |             |                                                                            |
| 5  | Make recommendations to the government to establish strict regulations related to the | If it fails | Make internal evaluations and controls                                      |
|    | agricultural sector and the provision of agricultural sector budgets, including     |             |                                                                            |
|    | evaluating and controlling the performance of Gapoktan                               |             |                                                                            |
| 6  | Increase community participation in agriculture through empowerment activities carried | If it fails | Make a pilot program with an interesting approach                           |
|    | out by Gapoktan                                                                       |             |                                                                            |
| 7  | Increase the role of youth in agriculture through workshops and the introduction of  | If it fails | Involving community leaders and millennial speaker figures who are         |
|    | agriculture from an early age                                                        |             | successful in agriculture                                                  |
| 8  | Providing information technology literacy training for farmers and youth              | If it fails | Providing onsite training model recognition activities                      |

### Table 5. SWOT-AHP alternative solution.

| O       | T                                                                 |
|---------|------------------------------------------------------------------|
| S       | Strict regulations related to the agricultural sector and the   |
|         | provision of agricultural sector budgets                         |
| W       | Increasing community participation in agriculture through the   |
|         | performance of farmer group union                                |
|         | Application of agricultural technology innovations through the  |
|         | role of Gapoktan                                                |
|         | Increase the role of youth in agriculture through workshops and |
|         | the introduction of agriculture from an early age                |
|         | IT literacy training for farmers and youth                       |
5. Conclusion
From a case study of increasing rice productivity in West Java, it can be seen that social factors such as farmer’s behavior and the role of the community have an impact on agricultural activities that affect rice productivity. The results of the study indicate that the role of Gapoktan and farmer regeneration are very important consideration factors. In this case study it was proven that the combination of SWOT and AHP methods was useful for measuring the priority of factors in the SWOT analysis. Further research can involve relevant stakeholders needed to get more accurate results.

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