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Sustainability Of Sweet Potato Farming In Kuningan Regency

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ABSTRACT

Sweet potato farming in Kuningan Regency has great potential in supporting food security and improving farmers' welfare. However, challenges such as fluctuations in production, deterioration and land shrinkage, as well as the impact of environmental changes and conventional agricultural practices threaten long-term sustainability. This study aims to: 1) Analyze the sustainability status of sweet potato farming. 2) Developing a strategy for the development of sustainable sweet potato farming. This study uses a mixed method with a survey approach to 100 farmer respondents and in-depth interviews with 17 related experts. Data analysis techniques include *Multi-aspect Sustainability Analysis* (MSA) to assess the status of sustainability and identify sensitive factors that affect each dimension of sustainability. The results of the study show that the sustainability status of sweet potato farming in Kuningan Regency is in the category of "Sustainable" with a sustainability status value (77.53). The sustainability status value in each dimension shows that the governance and governance dimensions have the highest score (86.83%) in the "Highly Sustainable" category, while the ecological (78.19%), economic (68.73%), and social (76.38%) dimensions are in the "Sustainable" category. The scenario analysis identifies scenario 1 (Moderate) as the optimal choice for governance, economic, and social dimensions, focusing on improvements on the two driving indicators in each dimension, while scenario 2 (Optimistic) is more appropriate for the ecological dimension, as it has the potential to improve sustainability status through improvements on the four driving indicators. This approach is projected to be able to maintain and improve the sustainability status of sweet potato farming in the future.

Keywords: Sustainability, *Multi-Aspect Sustainability Analysis* (MSA), Sweet Potatoes, Farming.

BACKGROUND

Indonesia, with its status as an agriculture-oriented country, is endowed with abundant biodiversity and has great potential in the agricultural sector. Sweet potato (*Ipomoea batatas L.*), also known as sweet potato, is one of the important commodities in food and agriculture. Sweet potatoes play an important role in supporting food security, increasing farmers' incomes, and encouraging diversification of agricultural products (Haris et al., 2018).

Sweet potatoes are a source of carbohydrate energy and can be used as an alternative food other than rice, feed ingredients, and industrial raw materials, making the demand for sweet potatoes in the market quite high (Suharyon & Edi, 2020). Although the demand for sweet potatoes is quite high for domestic consumption, food processing industry, animal feed, and export markets, challenges remain in ensuring increased production and quality of sweet potatoes in order to meet the needs of domestic and international markets. In addition, sweet potatoes have great market potential, Sweet potato production in Indonesia has faced instability and has yet to reach optimal levels, which

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directly impacts its ability to meet market demand. This unmet demand is reflected in a declining trend in market uptake and distribution efficiency in recent years, indicating challenges in aligning production output with consumer needs (Agricultural Data and Information Systems Center, 2023),.

According to Agricultural Data and Information Systems Center (2023), Sweet potato production in Indonesia still shows significant fluctuations and tends to experience a downward trend with an average of 1.15% per year during the 2019-2023 period. This shows that the average productivity of sweet potatoes has not reached the expected optimal target, which is between 25-40 tons per Ha (Hidayat et al., 2023). Some of the factors causing this decline include the low use of superior seeds, the nature of seasonal production, changes in land use, pest attacks and diseases that interfere with crops, and climate change, which has had an impact on the decline in the yield area and productivity of sweet potatoes over the past few years (Kangile et al, 2020).

The development of sustainable sweet potato farming in Indonesia faces a number of complex challenges that include various characteristics in the production system. These challenges include small business scales with limited capital use, the application of agricultural technology that is still not optimal, and the lack of a food commodity zoning system in accordance with the principles of agricultural development (Irawan, 2011). In addition, there is an imbalance in the production arrangement between supply and demand, weaknesses in the harvest and post-harvest handling systems, and low efficiency in the marketing system, where the price of products is often determined by traders, not farmers.

Ministry of Agriculture (2023), mentioning that the total national sweet potato production will reach 1,430,341 tons in 2023, where West Java Province accounts for around 27.06% of the total national production, thus making West Java Province the main center of sweet potato production in Indonesia, followed by East Java Province and West Sumatra Province. However, the productivity potential of sweet potatoes in West Java is still not fully optimal. Data shows that between 2013 and 2022, the harvest area and production volume of sweet potatoes in West Java experienced an average downward trend of 4.34% and 4.88% per year. This decline shows that there are challenges that need to be overcome to maximize the potential of sweet potato farming in this province.

The decline in production and sweet potato harvest area in West Java has an impact on the production center area in West Java Province. One of them is Kuningan Regency. Based on data DTPH West Java Province (2023), the average sweet potato production in 2017-2022, Kuningan Regency is the main contributor by supplying more than 8% of the total production at the provincial level. However, based on data from BPS Kuningan Regency (2020), during the period 2014-2023, the sweet potato harvest area in Kuningan Regency fluctuated with an average downward trend of 2.07% per year. This decrease in harvest area has an impact on sweet potato production, which decreases by an average of 3.65% per year.

Sweet potato farming in Kuningan Regency plays an important role in supporting the local economy and has great potential for regional economic development. The existence of large and fertile land supports the practice of sweet potato farming which is considered profitable. However, this land use needs to be done wisely to ensure long-term sustainability, not only providing momentary economic benefits but also taking into account the interests of future generations. In addition, the selection of appropriate commodities and maintaining the quality of land to remain productive are factors in increasing production and farmers' income (Mapiye et al., 2021). However, sweet potato farmers face challenges in implementing conventional agricultural systems, which often fail to align with the principles of sustainable agriculture. These principles include environmental stewardship, economic viability, and social equity. Conventional practices may neglect aspects such as preserving soil health, minimizing chemical inputs, promoting biodiversity, and ensuring fair labor practices, which are fundamental to sustainable agricultural systems (Rivai, 2011). Irresponsible land management practices and disregard for soil conservation principles can result in land degradation and an increase in critical land areas (Chatra et al, 2024).

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The importance of maintaining sweet potato farming so that it remains sustainable in the future is an important part of efforts to achieve food security and farmers' welfare. According to Snapp (2017), the adoption of the latest innovations and technologies plays a crucial role in enhancing efficiency and productivity in farming practices. These advancements enable farmers to optimize resource utilization, reduce production costs, and improve crop yields, thereby addressing the challenges of modern agriculture. According to Mahfujul et al., (2021), achieving sustainability in the agricultural sector necessitates adherence to key principles, including environmental protection, technical compliance, and economic viability. These principles ensure that farming practices maintain ecological balance, meet established technical standards, and contribute to long-term economic stability for farmers and communities. The sustainability of farming is highly dependent on the interaction and balance of its supporting components. These components include governance and institutional frameworks, ecological preservation, economic resilience, and social equity. The interconnectedness of these elements ensures that farming systems can adapt to challenges and remain viable in the long term (Junaedi et al., 2023).

Based on this background, this research will examine the sustainability status and pinpoint sensitive attributes within the four dimensions of sweet potato farming: governance, ecology, economic resilience, and social aspects. By identifying these attributes, the study aims to uncover the specific barriers and opportunities that influence the sustainability of sweet potato farming in Kuningan Regency. This approach will provide actionable insights into optimizing resource utilization, enhancing productivity, and improving the ecological balance while ensuring economic and social well-being. The findings will guide the formulation of targeted strategies that align with sustainability principles, such as promoting institutional support, encouraging the adoption of innovative practices, and fostering equitable social frameworks. Ultimately, the study's outcomes will contribute to achieving food security, improving farmer welfare, and establishing a robust framework for the sustainable development of sweet potato farming in the region.

RESEARCH METHODS

This study used a mixed method with a concurrent embedded design, which combines quantitative data collection and analysis as the primary method and qualitative data as a secondary method, provides a more comprehensive understanding of research issues (Creswell, 2018). Primary data was obtained directly from the field through measurements, questionnaires, observations, interviews, and focus group discussions (FGDs) with various respondents, such as farmers, entrepreneurs, community leaders, bureaucrats, and academics, to provide detailed information and describe the latest dynamics in the field, strengthen the validity of research results, and provide a comprehensive overview of sustainability conditions and challenges from various perspectives. Secondary data complements primary information and is obtained from literature studies, profiles, annual reports, guidebooks, and various related agencies (Suggestion, 2023).

The research was carried out in Kuningan Regency, which is the largest producer of sweet potato commodities in West Java. Sampling of the research site was carried out in stages. The first stage determines the sub-districts in Kuningan Regency which are the center of sweet potato production and there are 14 sub-districts. Then one sub-district with the highest sweet potato producing criteria in Kuningan Regency was selected, namely Cilimus District. The sampling was conducted using probability sampling and proportional random sampling techniques, involving 100 sweet potato farmers from 13 villages in Cilimus District. The farmers were selected based on proportional representation from a total population of 5,832 farmers, using Slovin's formula with a 10% margin of error to ensure accurate representation. Additionally, 17 experts were selected through purposive sampling, considering their expertise, reputation, experience, commitment to sustainability

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issues, neutrality, and availability. These experts included businessmen, community leaders, bureaucrats, and academics, ensuring a balanced (Sugiyono, 2023).

Multi-aspect sustainability analysis (MSA) was used in this study to evaluate the sustainability status of sweet potato farming, focusing on the current assessment conditions as well as planning more sustainable future strategies. Multi-aspect sustainability analysis (MSA) not only evaluates the sustainability status of current conditions, but also provides possible projections on future conditions, identifying driving factors/indicators (leverage factor), as well as priority policy scenarios that must be implemented. The results of the analysis include various dimensions of sustainability, validated through random iterations (Firmansyah, 2022).

The indocutor used is an adoption of best practices from various previous studies and research from Sustainability Assessment Food and Agriculture (SAFA) Guideline. Based on guidelines published by FAO (2014), SAFA has 4 sustainability dimensions, 21 themes, 58 subthemes, and 116 indicators. Pretty et al (2011), showing that best practices from various successful cases in sustainable agriculture can be used as a guide to adjust indicators. Thus, the adjustment of sub-dimensions and sustainability indicators is an important step to ensure the relevance, effectiveness and applicability of the assessment. Thus, in this study there are a total of 4 main dimensions analyzed, namely Governance and Government, Ecology, Economy, and Social. Each dimension consists of several themes totaling 16 themes and 38 sub-themes, to evaluate each sub-theme, 63 indicators designed to measure the status of sustainability are used. This structure allows for a comprehensive assessment of various aspects that affect the sustainability of sweet potato farming in Kuningan Regency.

The main advantage of MSA is its ability to update assessments at any time without having to perform in-depth re-analysis or use new models. One of the modeling methods that supports the implementation of MSA is the Exsimpro software, which is a development of RAPFISH, with the principle of rapid evaluation involving relevant stakeholders or individuals through interviews or focus group discussions (FGDs) (Firmansyah, 2022). The stages of MSA sustainability analysis include aggregate status assessment, projection of future conditions, validation of results, and structuring of priority policy scenarios, as described in Figure 4.

Sustainability and performance values are determined from the aggregate of various aspects. This value can be an aggregate average or the result of a pair comparison calculation. Usually, this value ranges from 0%-100%. On the X-axis, closer to 100% indicates better status or performance, while values closer to 0% indicate lower performance. Future conditions can be seen from the value on the Y axis. If the value is more than 50% and close to 100%, future conditions tend to increase. Conversely, if the value is below 50% and close to 0%, future conditions tend to decline. The sustainability assessment criteria in this study use 5 criteria that can be seen in Table 1.

Table 1**.** Sustainability Status Value Criteria

Status Value Criteria	Status Naming		Status Color (Map)
	Sustainability	**Performance**	
0-20	Unsustainable	Poor Performance	**Red**
> 20-40	Less Sustainable	Low Performance	**Orange**
> 40-60	Quite Sustainable	Medium Performance	**Yellow**
>60-80	Sustainable	Good performance	**Light green**
>80-100	**Highly Sustainable**	**Excellent Performance**	**Dark green**

Source: Firmansyah, 2022.

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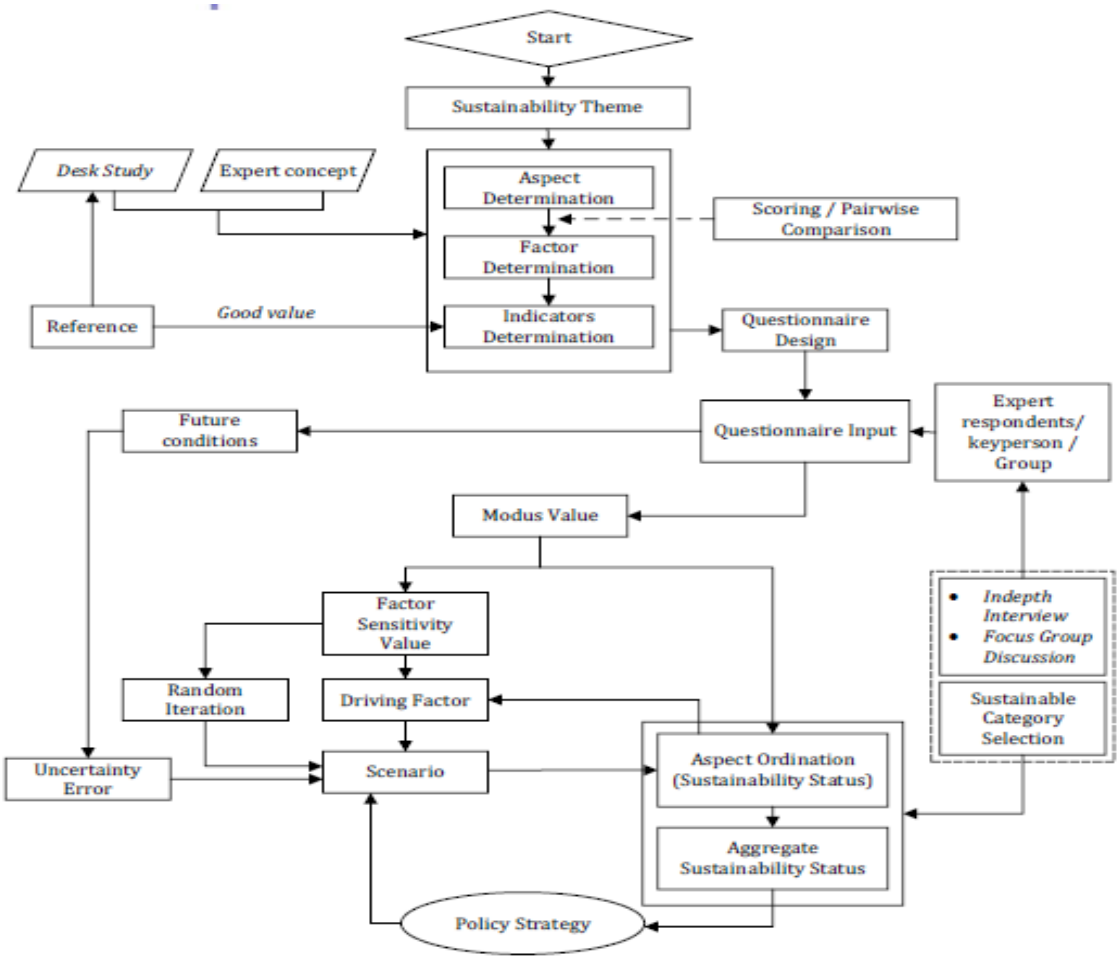

Figure 1. MSA Conceptual Framework

Source: Firmansyah, 2022.

The formula (1-3) for calculating the sustainability status value in these aspects is as follows, (Firmansyah, 2022):

$$Y = \frac{y_{f1} + y_{f2} + y_{f3} + y_{f4} + \cdots + y_{fn}}{fn} \times 100\% \quad (1)$$

$$y = \frac{\sum y_{fn}}{fn} \quad (2)$$

$$Y_{fn} = \frac{M_0 . f_n}{Gf_n} \quad (3)$$

Where Y is the sustainability status value, yf is the aspect factor, Mo is the mode value on the factor, G is the highest score (good) on the indicator factor assessment, and f is the factor value (Firmansyah, 2022).

Formula (4) is used to calculate the status value of the possible future sustainability, (Firmansyah, 2022):

$$F_c = \frac{MoC_1 + MoC_2 + MoC_3 + MoC_4 + \cdots + MoC_n}{n} \times 25 \quad (4)$$

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Where Fc is the value of the future probability on the dimension, Mo is the value of the mode, C is the value of the future condition on the indicator, N is the sum of the aspects. The values used include 0 (greatly decreased), 1 (decreased), 2 (fixed), 3 (increased), and 4 (greatly increased). A value of 25 is used as a standard for normalizing the result to 100, since the highest future condition value is 4. Therefore, to get a value of 100, this result needs to be multiplied by the future probability factor. If a factor has reached the highest (good) value, the future condition scenario cannot be improved further. On the other hand, if a factor has reached its lowest (bad) value, the scenario of future conditions cannot be derived anymore.

After obtaining the status value, to strengthen the conditions and the selection of policy scenarios, it is necessary to carry out a condition mapping based on the status value that has been generated. Some of the conditions identified include good, priority, important, urgent, bad, and illogical. The distribution position or state based on conditions has a sequence of importance as shown in Figure 2.

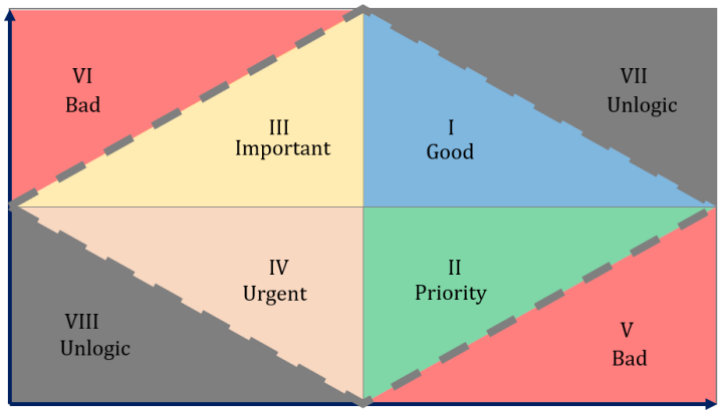

Figure 2. Determination of Conditions Based on Status Values

Source: Firmansyah, 2022.

Based on the determination of these conditions, each condition is assessed as follows: a) Group I with good condition: This condition is highly expected, b) Group II with priority condition: This condition is expected, c) Group III with important condition: This condition is less expected, d) Group IV with urgent condition: This condition is not expected because. Meanwhile, Groups V-VIII are categorized as unsuitable groups because they have a high level of uncertainty. Therefore, when determining the order of policies, in addition to considering the most sensitive factors, the first priority is to choose policies based on the order of groups IV, III, II, and I, which means that bad conditions must be corrected first.

Sustainability improvement strategies or scenario selection can be made from the status values in the scenario results using *Multi-aspect Sustainability Analysis* (MSA). In addition to the value of the scenario, *the leverage factor* is also the basis for the analysis of the scenario raised. The analysis of cascading scenarios (moderate scenarios, optimistic scenarios, and progressive scenarios) can be determined by selecting the number of scenarios and driving factors to be analyzed (Firmansyah, 2022).

The validation of the selected policy scenario is to compare scenario 1, scenario 2, and so on. The criteria for determining priority scenarios are taken with the consideration that the value of scenario 2 must be twice or higher than scenario 1 and scenario 3 must be 3 times higher than scenario 1 when this scenario is taken as a priority choice. Meanwhile, if it is still derived from the most likely and optimal scenario, then it would be better to take the previous scenario. The calculation of the priority value of the scenario can be seen in formula 5, (Firmansyah, 2022):

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$$\Delta y_n = y_{sn} - y_0$$
$$\Delta Y = \overline{y_n} - \overline{y_N}$$
$$P_{sn} = \frac{Y_n}{Y_1}$$
$$\frac{Y_n}{Y_1} > n \quad (5)$$

Where y is the state value, Ys is the scenario state value, Δyn is the difference between the scenario state value and the existing state value, n is the number of aspects, ΔY is the difference between the scenario value and the aggregate state value, Ps is the priority of the scenario, Yn is the difference between the scenario value n to scenario 1, and Y1 is the existing value = 1

RESULTS AND DISCUSSION

Sustainability Status of Sweet Potato Farming in Kuningan Regency

The analysis of the sustainability of sweet potato farming in Kuningan Regency aims to assess and understand the level of sustainability of sweet potato farming practices in the area. This research was conducted with a multi-dimensional approach involving aspects of governance and governance, ecology, economic resilience, and social. Kuningan Regency was chosen as the research location because it has great potential in sweet potato production. However, on the other hand, Kuningan Regency still faces various challenges that can affect agricultural sustainability, including climate change, changing agricultural policies, and uncertain market dynamics.

This multidimensional approach allows for a more comprehensive analysis in evaluating the condition and sustainability performance of sweet potato farming in Kuningan Regency. Through the criteria used, a clear picture of the current sustainability status and the direction of improvement needed to improve sustainability in the future is obtained. This assessment involves the active participation of sweet potato farmers and related experts. The assessment indicators used in this study refer to the study according to the Leknoi et al (2023); Lorenzo ET AL (2019); Jason et al (2023); Robert et al (2019); Mahfujul et al (2021); Butti et al (2019), which develops sustainability indicators for a wide range of agricultural practices. The sustainability status of sweet potato farming in Kuningan Regency can be seen in table 2.

Table 2. Sustainability Status of Sweet Potato Farming in Kuningan Regency

No	Dimension	Sustainability Status Values
1.	Governance and Government	86,83
2.	Ecology	78,19
3.	Economic Resilience	68,73
4.	Social	76,38
	Average	77,53
	Sustainability Status	Sustainable

Source: Primary Data Processed, 2024.

Table 2, shows that the sustainability status of sweet potato farming in Kuningan Regency falls into the 'sustainable' category, reflecting positive and relatively stable performance across various assessed dimensions. This indicates a good balance between effective governance policies,

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environmentally sound practices, economic resilience, and active social engagement (Schaller, 1993). The scores obtained suggest that current farming practices in Kuningan Regency generally align with the foundational principles of sustainability. However, when compared to relevant thresholds or benchmarks from the literature, there are indications that certain dimensions, while adequate, have yet to reach their full potential. For instance, improvements in ecological efficiency or social equity could further enhance sustainability levels. Identifying and addressing these areas of improvement would provide an opportunity to elevate sweet potato farming in Kuningan Regency to a higher sustainability standard, yielding greater long-term benefits for farmers and the surrounding environment..

Figure 3. Flyover Diagram of the Sustainability Status of Sweet Potato Farming in Kuningan Regency

Source: Primary Data Processed, 2024.

Overall, the sustainability status of sweet potato farming in Kuningan Regency is at a good level, with various dimensions showing positive performance as shown in figure 3. The governance and government dimensions have the highest scores, falling into the "Highly Sustainable" category, reflecting the success of local governments in implementing regulations, policies, and governance that support sustainable sweet potato farming practices, including integrated agricultural outreach that increases farmers' capacity. The ecological dimension is in the category of "Sustainable," showing farmers' awareness and efforts as well as the government's support in implementing environmentally friendly agricultural practices, although there are still challenges in the adoption of environmentally friendly technologies Increased awareness of farmers needs to be accompanied by strong policy support from the government to encourage farmers to switch to sustainable agricultural practices (Rahmawati et al., 2023). The ecological dimension also shows good performance, with the category "Sustainable", although currently, environmentally friendly agricultural practices are starting to be adopted by farmers, but consistency in the application and access to environmentally friendly technologies remains a major challenge, sustainable agricultural practices must pay attention to the wise management of natural resources to maintain the sustainability of local ecosystems (Adi Nugraha & Ekowati, 2024). The economic resilience dimension also shows good performance, with the category "Sustainable," although there are still challenges in increasing access to modern technologies that can strengthen long-term economic stability, economic resilience is one of the important pillars in agricultural sustainability, where the ability of farmers to manage economic risks and generate stable income is an indicator of long-term sustainability (Diartho, 2024). In the social dimension, sweet potato farming in Kuningan Regency is also considered "Sustainable," with

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adequate levels of farmer welfare, community involvement, and relationships between stakeholders, despite challenges in access to information and technology that can increase community capacity, social participation and community involvement are key in achieving agricultural sustainability (Malihatun et al., 2024).

Coordination, Future Conditions, and Sensitive Indicators (*Leverage*) of the Sustainability of Sweet Potato Farming in Kuningan Regency

Based on the results of the analysis that can be seen in figure 4, the governance and governance dimensions of sweet potato farming in Kuningan Regency currently show an excellent sustainability status, with a value of 86.83 which places it in the category of "very sustainable". The position of this dimension coordinates is in Group or Quadrant I, which reflects strong conditions with X-Axis values above 50, indicating that sustainability practices in the current conditions have been well implemented. In addition, a Y-Axis value above 50 indicates the potential for improvement or at least sustainability stability in the future, provided that the supporting factors are maintained. However, a lower future condition value of 56.15 indicates uncertainty in maintaining this sustainability in the future. Challenges faced by sweet potato farming include the potential for decreased stakeholder participation, uncertainty over legal rules that can be detrimental to smallholders, and holistic management that is not optimal in considering all aspects of sustainability. According to (Parmawati et al., 2024), good governance includes the active participation of all stakeholders, including local communities and farmer groups, in the decision-making process. Meanwhile, the results of the analysis of sensitive factors (*leverage*) of the 12 indicators studied, there are 5 main indicators that have a significant influence on the sustainability of sweet potato farming. The five indicators are Full Cost Accounting, Repair, Recovery, and Prevention, Barriers to Engagement, Consent Based on Preliminary Information Without Coercion, and Stakeholder Identification. These factors show that governance and government indicators related to cost transparency, remediation and prevention mechanisms, and stakeholder engagement and consent play an important role in determining the sustainability of farming. This is indicated by the total value *Sensitivity Max* and *Sensitivity Value,* which is higher than other variables.

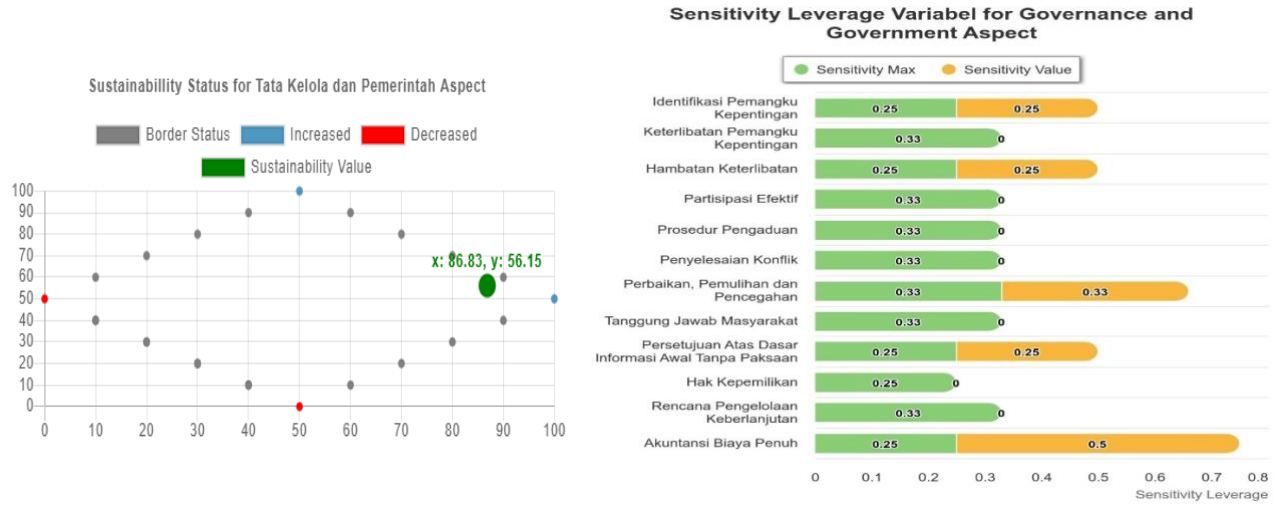

Figure 4. The Value of Ordination Status and Sensitive Factors for the Sustainability of Sweet Potato Farming in the Governance and Government Dimensions in Kuningan Regency

Based on the results of the analysis that can be seen in figure 5, the ecological dimension of sweet potato farming in Kuningan Regency currently shows a good sustainability status, with a value of 78.19 which places it in the category of "sustainable." The coordination position of this dimension is in Group or Quadrant II, which reflects good conditions with an X-Axis value above 50, indicating

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that sustainability efforts in water, soil, and materials and energy management are quite effective. However, a Y-Axis value below 50 indicates a potential decline in sustainability in the future, caused by challenges such as limited water availability due to climate change, deterioration of soil quality due to agricultural intensification, and suboptimal waste management. Agricultural sustainability relies heavily on effective management of natural resources, including water, soil, and energy. In addition, climate change and uncontrolled resource use can exacerbate environmental degradation, which will ultimately reduce agricultural productivity (Tri et al., 2022)**.** The lower value of future conditions, which is 49.69, confirms the uncertainty in maintaining this sustainability in the future. For this reason, wiser strategic steps are needed in natural resource management, the implementation of sustainable agricultural practices, and increasing farmers' awareness of the importance of environmental conservation in order to maintain and improve the sustainability status of this ecological dimension in the long term. The results of the analysis of sensitive factors in the ecological dimension for the sustainability of sweet potato farming in Kuningan Regency revealed that out of a total of 12 indicators studied, there were 9 indicators that had a significant influence on the sustainability of farming. The five main indicators that have the highest sensitivity values are Water Quality, Soil Quality, Fertilizer and Pesticide Use, Natural Resources Conservation, and Waste Management. Meanwhile, other indicators also have a fairly high sensitivity and influence value on the sustainability of sweet potato farming, although not as strong as the five main indicators, but have an equally important role in supporting long-term sustainability. These factors suggest that ecological aspects related to environmental health and quality, as well as conservation and rehabilitation efforts, play an important role in determining the sustainability of sweet potato farming. This is shown by the existence of a *Sensitivity Max* and *Sensitivity Value*, which is higher than other variables.

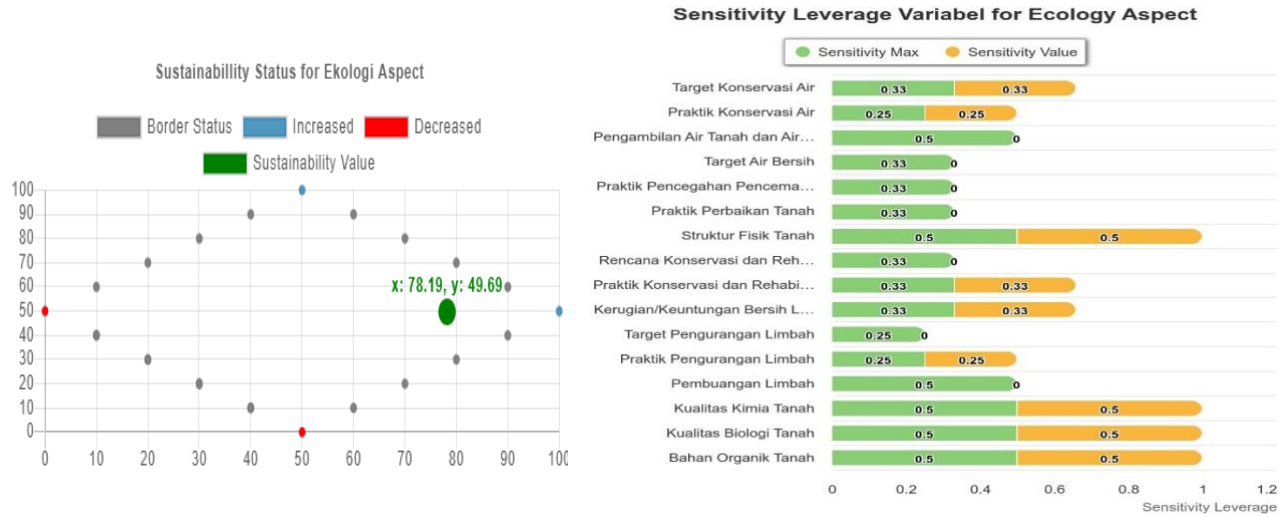

Figure 5. The Value of Coordination Status and Sensitive Factors for the Sustainability of Sweet Potato Farming in the Ecological Dimension in Kuningan Regency

Based on the results of the analysis that can be seen in figure 6, the economic resilience dimension of sweet potato farming in Kuningan Regency currently shows a good sustainability status, with a value of 68.73 which puts it in the category of "sustainable." The position of this dimension is in Group or Quadrant I, which reflects relatively stable economic conditions with X-Axis values above 50, indicating that economic practices such as internal investment, net profit management, and community development have been well implemented. However, a Y-Axis value above 50 indicates a potential increase, but also a risk of future decline if the existing challenges are not addressed. The lower future status value, which is 53.75, indicates the potential risk of a decline in economic resilience in the future. These challenges include investment uncertainty, vulnerability to fluctuations

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in production and market costs, and dependence on local economies and regional labor. Economic resilience in agriculture is highly dependent on diversifying sustainable sources of income and investment that can respond to market changes and external risks (Perwitasari et al., 2023). The results of the analysis of sensitive factors in the dimension of economic resilience showed that of the 22 indicators studied, 16 indicators had a significant influence on the sustainability of sweet potato farming, indicated by having a value of *sensitivity Max* and *sensitivity value* high. This indicates that changes in these indicators can significantly affect the sustainability of the economic resilience dimension in sweet potato farming. The five most sensitive indicators on the economic resilience dimension are Pricing, Business Plan, Production Rate Assurance, Production Cost, and Production Quality. This indicator has a direct impact on the sustainability of farming, given the dependence of farmers on economic factors that are closely related to financial management, production, and marketing. Meanwhile, other indicators also have a fairly high sensitivity and influence value on the sustainability of sweet potato farming, although not as strong as the five main indicators, but have an equally important role in supporting long-term economic stability.

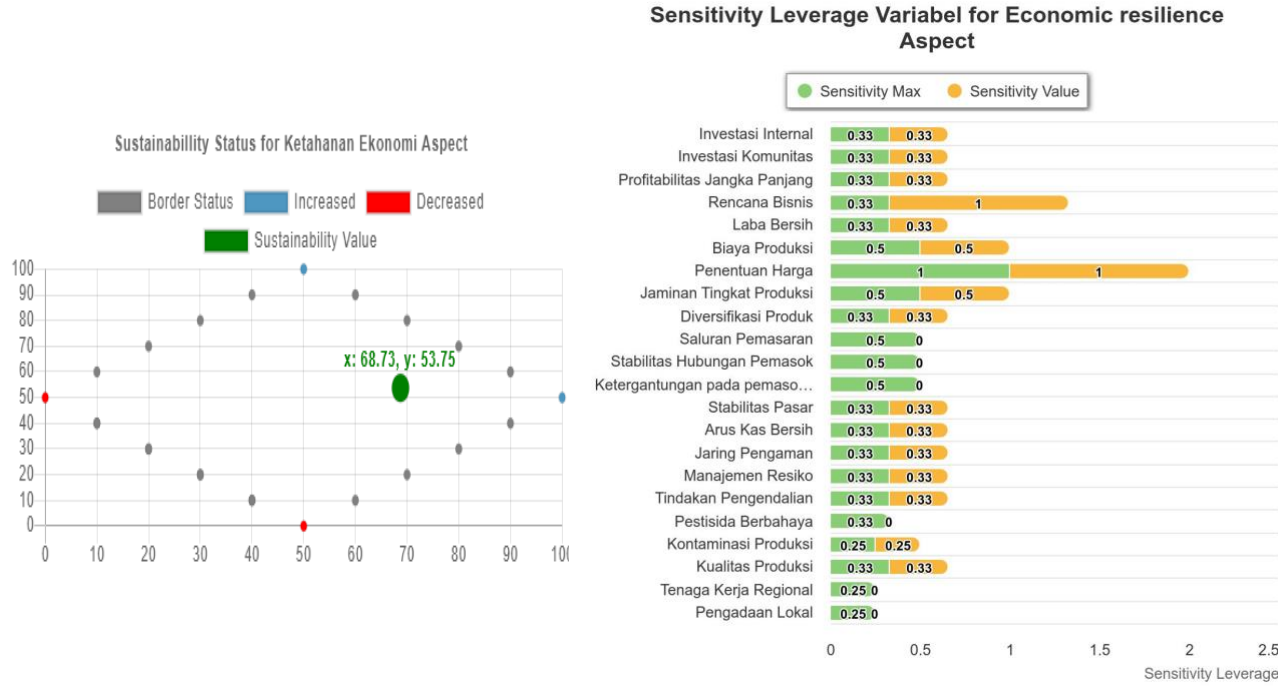

Figure 6. The Value of Ordination Status and Sensitive Factors for the Sustainability of Sweet Potato Farming in the Economic Resilience Dimension in Kuningan Regency

Based on the results of the analysis that can be seen in figure 7, the social dimension of sweet potato farming in Kuningan Regency currently shows a good sustainability status with a score of 76.38, placing it in the category of "sustainable." The position of this dimension coordinates is in Group or Quadrant I, which reflects relatively strong social conditions with X-Axis values above 50, indicating that various social aspects such as farmers' welfare and labor rights have been effectively implemented. Although there is a potential for future improvement with a Y-Axis value above 50, a lower future condition status value, which is 52.12, indicates that there are uncertainties or challenges that need to be managed. These challenges include the risk of a decline in decent livelihoods, uncertainty in fair trade, and potential labor rights violations. Social sustainability is highly dependent on the ability of communities to adapt and manage emerging social risks, both from economic and

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environmental changes (Analia et al., 2023). The results of the analysis of sensitive factors in the social dimension for the sustainability of sweet potato farming in Kuningan Regency revealed that out of a total of 13 indicators studied, there were 9 indicators that had a significant influence on the sustainability of farming. This indicates that changes in these indicators can significantly affect the sustainability of the economic resilience dimension in sweet potato farming. The five most sensitive indicators are the Right to Quality of Life, Workplace Safety, Operations and Facilities, Fair Pricing and Transparent Contracts, Capacity Building, and Fair Access to Means of Production. These factors play an important role in determining the sustainability of farming. This is shown by the existence of a *Sensitivity Max* and *Sensitivity Value* which is higher than other variables. Meanwhile, the other four indicators also have a fairly high level of sensitivity, although not as strong as the five main indicators, and still have an important role in supporting long-term economic stability in sweet potato farming in Kuningan Regency.

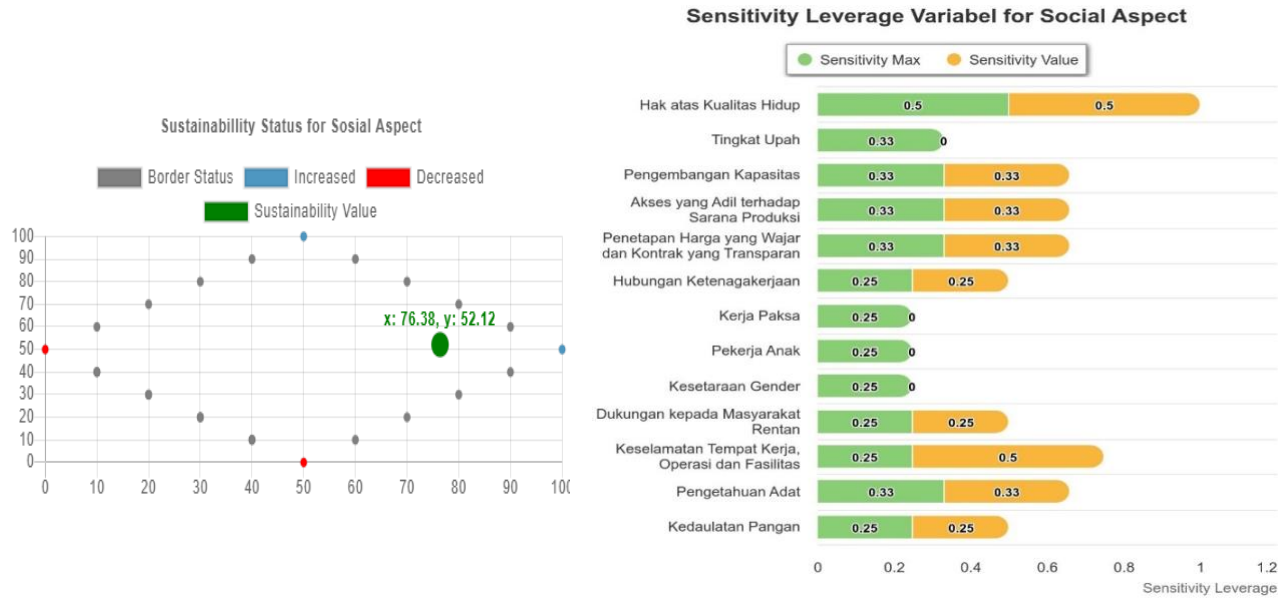

Figure 7. The Value of Ordination Status and Sensitive Factors for the Sustainability of Sweet Potato Farming in the Social Dimension in Kuningan Regency

Priority Scenario for Sustainable Sweet Potato Farming in Kuningan Regency

The criteria for selecting priority scenarios are by looking at a comparison of the values produced by each scenario created, optimistic scenarios are required to have a priority value twice that of moderate scenarios, while progressive scenarios must have a priority value three times that of moderate scenarios (Firmansyah, 2022). This approach is used to ensure that better scenarios significantly have an influence on the sustainability of sweet potato farming. A selective approach ensures that the selected scenarios not only meet the value criteria but are also able to provide practical, adaptive, and sustainable solutions, so that they can be a reference in formulating effective policies and strategies for the development of sustainable sweet potato farming. The value of the priority scenario of the strategy to increase sustainable sweet potato farming in Kuningan Regency can be seen in table 3.

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Table 3. Assessment of Priority Scenarios for Strategies to Increase Sustainable Sweet Potato Farming in Kuningan Regency

No	Dimension	S1	S2	S2/S1	S3	S3/S1
1.	Governance and Government	4,84	9,00	1,86	11,09	2,29
2.	Ekologi	6,25	12,50	2,00	14,56	2,33
3.	Economic Resilience	7,59	12,13	1,60	15,13	1,99
4.	Social	5,77	10,85	1,88	13,29	2,32
	Average Priority Scenario			1,88		2,32

Source: Primary Data Processed, 2024.

Information:

S1: Skenario 1 (Moderate)

S2: Scanner 2 (Optimis)

S3: Scenario 3 (Progressive)

Table 3, shows that the decision of the priority scenario analysis revealed that some scenarios did not fully meet the criteria that had been set for the development of sustainable sweet potato farming in Kuningan Regency. The priority scenarios in the dimensions of governance and government, economic resilience, and social, both scenario 2 and scenario 3 have not met the requirements, because the values produced do not reach the set criteria, which are double and triple the total value of scenario 1. This, shows that despite the improvement, the changes generated by the optimistic and progressive scenario in these three dimensions are not significant enough to be considered as a top priority, so the priority scenario used is scenario 1. Meanwhile, for the ecological dimension, scenario 2 meets the criteria because it has a status value twice as high as scenario 1, indicating an increase in accordance with expectations for better environmental management. However, scenario 3 in the ecological dimension does not meet the criteria because it does not achieve a triple value of scenario 1, which indicates that despite greater efforts, the impact is not strong enough to meet the progressive target, so the priority scenario in the ecological dimension is scenario 2.

The sustainability status of sweet potato farming in Kuningan Regency was evaluated through a simulation of selecting priority scenarios in each dimension designed to develop sustainable sweet potato farming practices in Kuningan Regency. Efforts to develop sustainable sweet potato farming can integrate the driving indicators of each scenario produced, so that it will have greater potential to achieve the desired sustainability status in the future (Junaedi et al., 2023). The sustainability status of the priority scenario for the development of sustainable sweet potato farming in Kuningan Regency can be seen in figure 8.

Figure 8, shows that the sustainability status of the priority scenario for the development of sweet potato farming in Kuningan Regency shows a significant increase in the value of sustainability status in the future after the implementation of the priority scenario compared to the current concession. The current sustainability conditions show that various dimensions that support the sustainability of sweet potato farming still need improvement efforts to reach the optimal level. After the simulation of selecting priority scenarios was implemented, there was a good improvement in the overall sustainability status, with the average value rising from the current sustainability status value of 77.53 to 85.21. With the support of appropriate policies and the implementation of best practices, the sustainability status in agriculture can not only be maintained but also improved in the future (Hanifawati et al., 2018).

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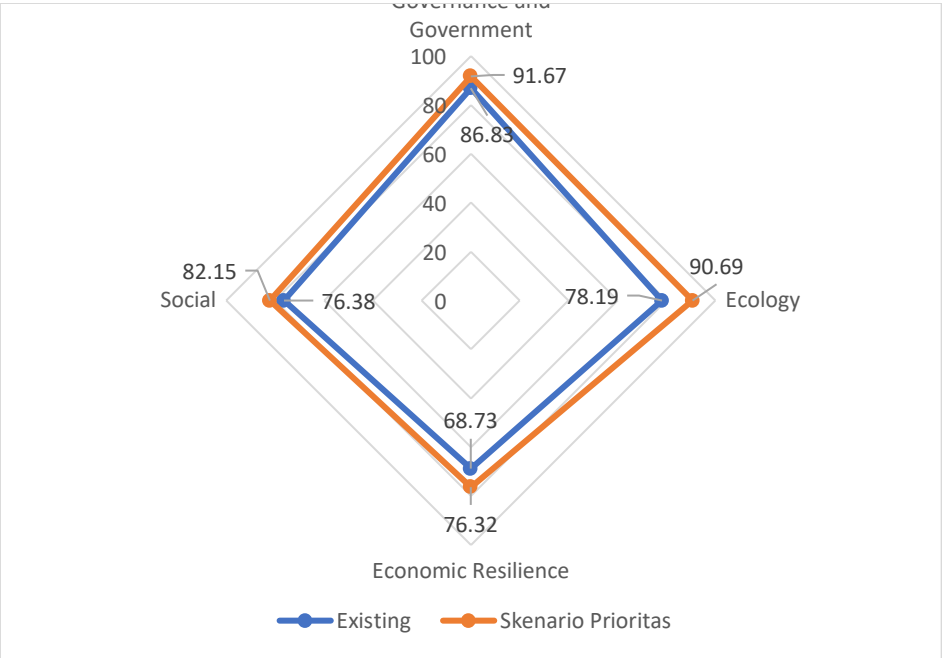

Figure 8. Sustainability Status of Priority Scenarios for the Development of Sustainable Sweet Potato Farming in Kuningan Regency

Source: Primary Data Processed, 2024.

Strategic implications and a comprehensive action plan are needed in facing various possibilities for the development of sweet potato farming in Kuningan Regency in the future, and are prepared based on a combination of driving indicators in each dimension that have been designed and simulated in priority scenarios, then an action plan is prepared with expert informants. This action plan is designed not only to be proactive in facing challenges and taking advantage of future opportunities, but also to provide the necessary reactive steps if an unexpected situation arises (Firmansyah, 2020). Through the identification and comparative analysis of various possible scenarios, policymakers and stakeholders can formulate more adaptive and effective strategies to address the dynamics of change that occur. The priority scenario for the development strategy of sustainable sweet potato farming in Kuningan Regency can be seen in table 4.

Table 4. Suggestions and Action Plans for Priority Scenarios for Sustainable Sweet Potato Farming Development Strategies in Each Dimension in Kuningan Regency

Key Scenarios and Indicators	Implications of the Suggestion	Plan Of Action
Governance and Government Dimensions		
1. Full Cost Accounting	Improve the accuracy of recording all production-related costs to create financial transparency and improve farming efficiency.	a. Develop a cost accounting guide for farmers that includes all elements of production-related costs. b. Holding regular financial management and cost accounting training for farmers in Kuningan Regency. c. Implement a community-based financial reporting system to monitor and improve accountability.

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Key Scenarios and Indicators		Implications of the Suggestion	Plan Of Action
2.	Repair, Recovery and Prevention	Ensure the implementation of policies that promote the improvement, recovery, and prevention of environmental damage through sustainable agricultural practices.	a. Implement a rehabilitation program for degraded land by involving local farmers. b. Building cooperation with research institutions for research and application of environmentally friendly technologies. c. Increase the capacity of agricultural extension workers to support the implementation of sustainable agricultural practices.
		Ecological Dimension	
1.	Chemical Quality of Soil	Optimizing the balance of nutrients and other chemicals in the soil through regular soil pH testing.	a. Reduce the use of synthetic chemicals through the use of organic fertilizers. b. Develop educational programs on the negative impacts of chemicals on soil quality and environmental health.
2.	Soil Organic Materials	Increase the content of soil organic matter to improve soil structure and fertility.	a. Encourage the use of compost and green manure in sweet potato farming practices. b. Conducting training on composting techniques and sustainable use of organic fertilizers.
3.	Soil Biological Quality	Improve soil health by improving the condition of organisms living in the soil which affects the fertility and quality of plants.	a. Rotate plants to support soil biodiversity. b. Implement organic farming practices to improve the biological quality of soil. c. Developing ongoing research on beneficial soil microorganisms.
4.	Physical Structure of the Soil	Maintain good soil physical conditions, including soil texture, porosity, and density, to support plant growth and water use efficiency.	a. Applying soil conservation techniques such as the use of ground cover, and crop rotation. b. Developing water-saving irrigation technology to maintain the physical structure of the soil.
		Economic Resilience Dimension	
1.	Pricing	Improve price stability and farmers' welfare through a fairer pricing mechanism, based on production costs, market value, and consumer purchasing power.	a. Build a minimum price policy mechanism for sweet potato products. b. Establishing farmer cooperatives to strengthen farmers' bargaining positions. c. Develop alternative markets and introduce joint marketing strategies to expand market reach.
2.	Business Plan	Increase the competitiveness and efficiency of farming with good production, marketing, and financial planning strategies.	a. Provide intensive training in the preparation of business plans for smallholders. b. Facilitate access to affordable sources of microfinance and microcredit. c. Running mentoring and mentoring programs for farmers in business management and agricultural business planning.
		Social Dimension	

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Key Scenarios and Indicators		Implications of the Suggestion	Plan Of Action
1.	The Right to Quality of Life	Ensuring a decent standard of living for farmers, including access to basic necessities such as clean water, education, health, and social protection.	a. Developing a focused social security program for farmers. b. Increasing access to health and education services through collaboration with relevant institutions. c. Disseminate information and education about basic farmers' rights through training and campaigns at the community level.
2.	Workplace, Operations and Facility Safety	Improve occupational safety and health as well as operational conditions to ensure that farmers' productivity remains optimal.	a. Implement a work safety training program for farmers. b. Provide adequate personal protective equipment (PPE). c. Improve agricultural infrastructure and work facilities in sweet potato producing areas. d. Develop a mechanism for reporting and following up on work safety incidents in the field.

Source: Primary Data Processed, 2024.

CONCLUSIONS AND SUGGESTIONS

Based on the analysis, sweet potato farming in Kuningan Regency is at a "sustainable" status. The dimensions of governance, economic resilience, and social show optimal performance and strong stability. The ecological dimension, however, reveals vulnerabilities such as soil fertility degradation, inefficient water use, and limited adoption of environmentally friendly farming practices, which require targeted interventions. Future sustainability indicators show potential declines in all dimensions, so appropriate mitigation measures are needed.

Sensitive indicators in each dimension highlight priority areas for improved sustainability. Indicators in every governance, ecological, social, and economic dimension require special attention to strengthen long-term resilience and sustainability. Sensitive indicators in each of these dimensions reflect specific challenges that need to be addressed through more effective agricultural policy and practice approaches. Overall, although sweet potato farming is currently in good condition, a more focused sustainable strategy is needed to maintain and improve sustainability status in the future.

In an effort to ensure the sustainability of sweet potato farming in Kuningan Regency, farmers need to be encouraged to adopt environmentally friendly technology, diversify products and markets, and implement environmental conservation practices. Institutional strengthening through the formation of farmer groups or cooperatives, improvement of infrastructure and market access, as well as continuous training and counseling are also needed. In addition, there needs to be policies that support sustainability and partnerships with various stakeholders, as well as research that focuses on natural resource management to maintain long-term agricultural productivity.

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