

THE SUSTAINABILITY OF HYBRID CORN FARMING IN SOUTH BENGKULU REGENCY

Diajeng Hasri Nabila Ramadhani^{1*}; Satria Putra Utama²; Musriyadi Nabiu²

¹Study Program of Agribusiness Magister Faculty of Agriculture, University of Bengkulu

²Department of Agricultural Socio-Economics, Faculty of Agriculture, University of Bengkulu.

*Corresponding Author

Diajeng Hasri Nabila Ramadhani

E-mail:

diajengnabila13@gmail.com

Article History

Received: 05.02.2023

Accepted: 02.04.2024

Published: 30.04.2024

Abstract: South Bengkulu Regency has a commodity that plays a role in economic development and provides multifunctional economic value, one of which is hybrid corn. In 2022, the contribution of corn production in South Bengkulu Regency reached 61,884 tons with a harvested area of 9,444 hectares (Bengkulu Provincial Agriculture Office, 2023). Specifically, in Seginim District and Kedurang Ilir District, which are the highest hybrid corn-producing areas in South Bengkulu Regency. To stabilize hybrid corn production in South Bengkulu Regency, it is necessary to develop sustainable agriculture to ensure the existence and availability of hybrid corn stocks. The sustainability analysis of corn farming in South Bengkulu Regency uses five dimensions: social, environmental, economic, technology and infrastructure, and institutions. This analysis is expected to evaluate the sustainability of hybrid corn farming so that the issues hindering its sustainability in South Bengkulu Regency can be addressed quickly and effectively. The objective of this research is to determine the index and sustainability status of hybrid corn farming in South Bengkulu Regency and to understand the interdependencies between attributes in hybrid corn farming in the region. The methods used are Multidimensional Scaling (MDS) and Prospective Analysis. The results indicate that South Bengkulu Regency falls into the category of less sustainable, with nine key attributes having a strong influence on the system.

Keywords: Hybrid Corn Farming; Agricultural Sustainability; Multidimensional Scaling; Prospective Analysis; South Bengkulu Regency.

Cite this article:

Ramadhani, D. H. N.; Utama, S. P.; Nabiu, M., (2024). THE SUSTAINABILITY OF HYBRID CORN FARMING IN SOUTH BENGKULU REGENCY. *ISAR Journal of Economics and Business Management*, 2(4), 49-62.

Introduction

The agricultural sector plays a strategic role as a provider of employment opportunities and in utilizing available natural resources to meet the needs of society (Harahap, 2018). South Bengkulu Regency is one of the regions with potential in the agricultural sector as a driver of the local economy. The utilization of the agricultural sector can increase the income of farming households to meet their needs. According to the South Bengkulu Regency BPS (2022) and Mulyaningsih (2018), the agricultural sector contributes significantly to economic growth and development, accounting for 32.95% of the total, and absorbs more than 50% of the workforce.

South Bengkulu Regency has a commodity that plays a role in economic development and provides multifunctional economic value, one of which is hybrid corn. This commodity is utilized for industrial needs, making hybrid corn farming a promising opportunity for future growth (TKTM, 2010). Hybrid corn farming contributes to the income of farming households, as seen in Alam (2021), where hybrid corn farming contributed up to 50 percent of farmers' household income. This is supported by findings from Utami et al. (2016), which showed that hybrid corn farming contributed 35.91% of the income in Ketapang District, while Arbi (2017) found that corn farming contributed only 8.51% to the household income of farmers in Gorontalo. Therefore, it can be concluded that even though the production results may not be large, it still significantly contributes to farmers' household income.

This high production is used to meet the demand for hybrid corn as one of the main raw materials for poultry feed (Tangendjaja & Wina, 2011). However, the availability is not yet sufficient to meet the increasing demand for hybrid corn due to the growth of the poultry industry (BPPKP, 2017). Therefore, the hope is that farmers in South Bengkulu Regency can contribute to meeting the demand for hybrid corn. In 2022, the contribution of corn production in South Bengkulu Regency reached 61,884 tons with a harvested area of 9,444 hectares (Bengkulu Provincial Agriculture Office, 2023). Specifically, in Seginim District and Kedurang Ilir District, which are the highest hybrid corn-producing areas in South Bengkulu Regency.

The production of hybrid corn in Seginim and Kedurang Ilir Districts is the highest among the eleven districts in South Bengkulu Regency. Based on the last three years (2020-2022), the average production of hybrid corn in Kedurang Ilir District reached 3 tons/ha, while in Seginim District it reached 6 tons/ha. This is in line with research by Taufik et al. (2015) and Resmayeti et al. (2016), which found that hybrid corn production in South Sulawesi was less than 5 tons/ha, and in Banten it reached 6-7 tons/ha. Given the increasing demand for hybrid corn for animal feed

as meat consumption rises, this situation is concerning as it may affect the fulfillment of hybrid corn demand for poultry feed production. One of the factors contributing to the increase in hybrid corn demand is the fact that in 2021, egg consumption reached 92.20% and poultry meat consumption reached 60.22% in Indonesia (Directorate General of Animal Husbandry, 2022).

The opportunity to increase hybrid corn production in South Bengkulu Regency is wide open due to the ability of hybrid corn to adapt to various types of soil. It is also noted that over the past three years, the harvested area of hybrid corn in Kedurang Ilir and Seginim Districts has continued to increase. According to Joko (2022), land is a key factor in farming practices for a commodity, as larger land area or increased harvested area will lead to higher production yields.

In addition, according to Anwar (2022), there are several key issues in hybrid corn farming, such as low production, inadequate technology availability, water supply, fluctuations in input prices, instability in corn prices in the market, and a lack of available capital.

The issues that arise present a challenge in maintaining the sustainability of hybrid corn farming. Additionally, sustainability is key to agricultural development as it holds the potential to meet future human resource needs. According to Junaidi (2017), Permatasari et al. (2018), and Sutiknjo (2017), sustainable agriculture is a concept that does not rely on chemicals, does not damage the environment, preserves biodiversity, maintains soil fertility, and ensures clean water. The concept used to assess sustainability includes ecological, economic, technological and infrastructure, as well as institutional aspects. The positive impacts of studying the sustainability of hybrid corn farming include meeting feed needs, providing profits for farmers, and ensuring ecological preservation (Sudaryanto et al., 2018).

The sustainability of hybrid corn farming in South Bengkulu Regency is analyzed using five dimensions: social, environmental, economic, technology and infrastructure, and institutions. The discussion on sustainability remains an ongoing topic of conversation. This is particularly interesting as it relates to the economic development of the agricultural sector in every country (World Bank, 2008). To achieve this, it is necessary to understand the factors that contribute to the success of sustainable farming, which requires proper planning and implementation of agricultural development. This aligns with the Indonesian Law No. 22 of 2019 on "sustainable farming," which is defined as a farming management approach that implements four dimensions: economic, ecological, social and cultural, and institutional dimensions. However, several experts also argue that in addition to these

four dimensions, there is another dimension: technology and infrastructure.

This analysis is expected to evaluate the sustainability of hybrid corn farming so that the issues hindering its sustainability in South Bengkulu Regency can be addressed quickly and effectively. The goal is for agricultural sustainability to meet the required feed needs and support farmers' economies without damaging the existing natural resources for the future (Sudaryanto et al., 2018). Additionally, by conducting a sustainability analysis of hybrid corn farming, it is hoped that it will provide an overview of the sustainability level and identify the steps that need to be taken to improve the sustainability of hybrid corn farming in South Bengkulu Regency.

The objective of this research is to determine the sustainability index and status of hybrid corn farming in South Bengkulu Regency and to understand the interdependencies between attributes in hybrid corn farming in the region.

Research Methods

Location and Time of Research

The research location was selected purposively. The consideration for this choice is that from 2020 to 2022, South Bengkulu Regency had the highest hybrid corn production among the other 10 regencies, as shown in Table 1. This research was conducted from December 2022 to January 2023. For detailed information, please refer to Table 1. The hybrid corn production in Bengkulu Province from 2020 to 2022 is shown below:

Kabupaten	Produksi (Ton)		
	2020	2021	2022
Bkl Selatan	28.105	51.582	61.884
Rj Lebong	16.952	21.144	8.313
Bkl Utara	8.292	17.297	10.357
Kaur	7.054	9.971	11.650
Seluma	7.820	9.667	12.292
Muko2	5.360	10.383	3.391
Lebong	7.411	7.097	9.598
Kepahiang	3.705	6.564	4.646
Bkl Tengah	4.562	1.205	482
Kota Bkl	136	139	41

Source : Agriculture Department of Bengkulu Province, 2022

Determination and Sampling Methods (Respondents)

The sampling method used in this study is simple random sampling. The respondents selected are hybrid corn farmers in South Bengkulu Regency. The population of this

study consists of hybrid corn farmers residing in South Bengkulu Regency, specifically in two districts: Seginim and Kedurang Ilir. The total population of farmers in this study is 787, with 322 farmers in Seginim District and 465 farmers in Kedurang Ilir District (Simluhtan, 2022). The sample size used for the respondents is determined using the sample size calculation formula with the bound of error (Nazir, 2013). The bound of error used is based on the variance of data on the area of hybrid corn farming as follows :

$$\begin{aligned}
 S^2 &= \frac{\sum(X_i - \bar{X})^2}{n - 1} \\
 &= \frac{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}{n - 1} \\
 &= \frac{\sum(84,70 - \frac{(\sum 92,28)^2}{125})^2}{124 - 1} \\
 S^2 &= 84,15
 \end{aligned}$$

$$BOE = 2\sqrt{V(x)}$$

$$2\sqrt{\frac{s^2(N-n)}{n(N-1)}}$$

$$2\sqrt{\frac{84,15(787-125)}{125(787-1)}}$$

$$= 2\sqrt{0,67 \times 0,84}$$

$$BOE = 2\sqrt{0,57} = 1,51$$

$$BOE = B, \text{ maka } B = 1,51$$

$$D = \frac{B^2}{4} = \frac{1,51^2}{4} = 0,57$$

$$n = \frac{Ns^2}{(N-1)D + s^2}$$

$$n = \frac{787 \times 84,15}{(787-1)0,57 + 84,15}$$

$$n = 124,45 \sim 124$$

Where :

n = The sample size obtained randomly from the population N

N = Total population of hybrid corn farmers

Xi = Population size of land area

$\bar{X}$ = Mean population of land area

S² = variance

Based on the importance of identifying the attributes for each dimension to be analyzed using the MDS method, this study will involve 6 expert respondents, consisting of 3 academics, 1 extension officer, 1 agricultural officer from the South Bengkulu Regency Agriculture Office, and 1 corn trader who is relevant to the field. The selected respondents who will serve as experts must meet the following criteria:

- Possess expertise in the required field.

- b. Have credibility as an expert in each of the topics being studied, with a strong reputation and position in their area of expertise.
- c. Be objective and willing to provide opinions and viewpoints.

Method of Collecting Data

This research uses both primary and secondary data. According to Supriyono (2018), data collection can be conducted through two sources, namely:

Primary Data

Primary data is obtained directly through the distribution of questionnaires, with the criteria for evaluating the questionnaire for experts in determining each attribute. These criteria are based on a Likert scale from 1 to 5, with the following meanings: strongly disagree, disagree, neutral, agree, and strongly agree. To assess the direct influence between attributes in the system on the sustainability of hybrid corn, scoring is done using a scale of 0-3, with the following meanings: no influence, small influence, moderate influence, and strong influence. The questionnaire for farmers is designed based on information about hybrid corn farming in South Bengkulu Regency, and the assessment is conducted using a 1-4 Likert scale, where higher scores indicate better quality, and vice versa.

Secondary Data

According to Sugiyono (2010), secondary data is data obtained directly in the form of documents. The collection of secondary data in this research consists of data from BPS (Central Bureau of Statistics), the District, BPP (Agricultural Extension Center), and other relevant agencies.

Data Analysis

The data analysis method used in this study is the quantitative descriptive method. This descriptive analysis technique aims to describe regular patterns in the data so that the results obtained can have accurate meaning. According to Widodo (2014), the descriptive analysis method involves explaining facts appropriately, allowing us to compare certain phenomena or make comparisons.

Sustainability of Hybrid Corn Farming

The Rap-Farm method (Multidimensional Scaling) is used to evaluate the sustainability index and status of hybrid corn farmers in South Bengkulu Regency. The Rapid Appraisal Techniques for fisheries program, developed by the Fisheries Center at the University of British Columbia, was modified into the Rap-Farm approach (Fauzi, 2005). This method utilizes statistical analysis to transform one or more dimensions of farming sustainability (Rao, 2006).

The procedure for using this method involves determining the relative perceptions of an object (perceptual mapping). The following are the steps that will be taken in the analysis:

1. There are five dimensions to determine the sustainability attributes of hybrid corn farming, which include environmental, economic, socio-cultural, technological, and institutional dimensions.
2. Assign values to each attribute on an ordinal scale based on sustainability criteria for each dimension.
3. Formulate the sustainability index and status.

This analysis technique maps two objects or points to the same point that is interconnected (Nurmalina, 2008). The matrix X ($n \times p$) will form the score values for each attribute, where n is the number of regions and reference points, and p is the number of attributes used. The score values for each attribute are then standardized for each attribute's score, so that each attribute has equal weight and the differences between measurement scales can be eliminated. The standardization method is as follows :

$$X_{iksd} = \frac{X_{ik} - X_k}{S_k}$$

Explanation :

- X_{iksd} = Standardized score for region $i = 1, 2, \dots, n$, for each attribute $k = 1, 2, \dots, p$
- X_{ik} = Initial score for region $i = 1, 2, \dots, n$, for each attribute $k = 1, 2, \dots, p$
- X_k = Median score for each attribute $k = 1, 2, \dots, p$
- S_k = Standard deviation of scores for each attribute $k = 1, 2, \dots, p$

To analyze the Euclidean distance by looking at the closest distance score from MDS, Rapfish can be used. This is done using the following equation (1) :

$$d_{12} = \sqrt{(X_1 - X_2)^2 + (y_1 - y_2)^2 + \dots} \quad (1)$$

The Euclidean distance between the two points (d_{12}) is then projected into a two-dimensional Euclidean distance (D_{12}) based on the following regression formula (2):

$$d_{12} = a + bD_{12} + e ; e \text{ adalah error (Fauzi, 2002) } \dots \quad (2)$$

According to Kavanagh (2001), the ALSCAL algorithm is used in Rapfish for regression to achieve the lowest error value by performing it iteratively. The intercept value in the equation must be set to zero ($a=0$), so equation (2) becomes equation (3) as follows :

$$d_{12} = bD_{12} + e \dots \quad (3)$$

The iterative process stops when the stress value is smaller than 0.25. The stress value is obtained based on the following equation (4).

$$Stress = \sqrt{\frac{1}{m} \sum_{k=1}^m \left[\frac{\sum_i \sum_j (D_{ijk} - d_{ijk})^2}{\sum_i \sum_j d_{ijk}^2} \right]} \dots \quad (4)$$

The Monte Carlo analysis aims to evaluate the influence of random errors on the estimation process in the ordination function of hybrid corn farming with a 95% confidence level. If the difference between MDS and Monte Carlo results becomes smaller, the model generated will be considered better. Various types of errors in MDS analysis, including incorrect scores in the processing phase, value variations caused by differences in researchers' opinions, and the repetitive nature of MDS processing, can lead to large stress values and distorted data (Dzikrillah, 2017). A stress value of less than 25% or 0.25 indicates that the error level is acceptable.

Next, a Leverage analysis (sensitivity analysis) is conducted to determine the sensitive attributes of the sustainability of hybrid corn farming in South Bengkulu Regency. The analysis will also examine the coefficient of determination (R^2), where if $R^2 > 80\%$, the relationship between dimensions will be considered strong. According to Saidah et al. (2012), a model is considered to have a "goodness of fit" if it has an R^2 value $> 80\%$, approaching 100%. This study will focus on five dimensions: economic, environmental, technological, socio-cultural, and institutional. For the sustainability indicators of each dimension, several attributes will be selected that represent each related dimension. To assess the direct impact of these attributes on the sustainability system of hybrid corn farming, prospective participatory analysis will be used. The following are the steps that will be taken in this research :

RAPFARM Multidimensional Scaling Method

Determination and Scoring of Attributes for Each Dimension

To determine the attributes that will be used for each dimension, the process should begin with a review of relevant literature. This is followed by conducting a preliminary survey in the field to strengthen the results from the literature review with the real-world context of the research area. Subsequently, the sustainability criteria and characteristics for each dimension (technology, institutional, economic, socio-cultural, and environmental) are identified through literature studies and discussions with experts. According to Dzikrillah et al. (2017), understanding the characteristics of each sustainability dimension and assessing those characteristics must be based on concrete data through literature research, expert interviews, and field observations. In the sustainability dimension of hybrid corn, each dimension is assigned a Likert score from 1 to 4, where a higher score indicates that the sustainability of hybrid corn farming in South Bengkulu Regency is more supported.

Data Validity and Reliability Test

It is necessary to conduct testing on each question in order to measure the variables we have previously studied, and this requires validity and reliability testing (Usman,

2006). If the instruments are invalid or unreliable, the research results will not be accurate or trustworthy.

Validity Test

According to Arikunto (2006), validity is a measure to indicate the degree of accuracy or correctness of an instrument. The validity of data is a test conducted to determine the accuracy of the measurement tool used in a study, so that the variables and indicators in the research can effectively measure the parameters that have been established.

A questionnaire is considered valid if the questions can measure what they are intended to measure (Ghozali, 2009). The value of a variable is considered valid if the correlation value (r_{hitung}) is greater than the r_{tabel} value. In this study, 124 samples were used, where the value of r_{tabel} is determined by the formula $N - 2$, which is 122, with a r_{tabel} value of 0.1484 at a 0.05 significance level. The validity test will be conducted using SPSS version 24 with the following decision-making criteria :

1. If $r_{hitung} > r_{tabel}$ (0,1484), Therefore, the indicator is considered valid.
2. If $r_{hitung} < r_{tabel}$ (0,1484), Therefore, the indicator is considered not valid.

Reliability Test

This reliability test must be conducted because its purpose is to evaluate the method used to obtain data that can be utilized and provide accurate information in the field (Sitinjak, 2006). A questionnaire is considered reliable if the statements are consistent or stable over time (Ghozali, 2009). The reliability coefficient value is considered reliable if it is greater than 0.60. This test will be conducted using SPSS version 24 with the following decision-making criteria:

1. If the value *Cronbach Alpha* $> 0,6$, Therefore, the indicator is considered reliabel
2. If the valure *Cronbach Alpha* $< 0,6$, Therefore, the indicator is considered not reliabel

Determination of Criteria Scale and Sustainability Projection

Determining the sustainability status of hybrid corn in South Bengkulu Regency uses four sustainability status categories, which are assessed through Multidimensional Scaling (MDS) analysis. The sustainability criteria for each dimension are used to evaluate each attribute on an ordinal scale. Then, the attribute scores are analyzed using Microsoft Excel. According to Kavanagh and Pitcher (2004), sustainability index categories are based on the dimensions of each index, which are categorized as follows:

Index Value	Status Category
0,00-25,00	Bad; tidak berkelanjutan
25,01-50,00	Less; kurang berkelanjutan
50,01-75,00	Moderate; cukup berkelanjutan
75,01-100,00	Good; sangat berkelanjutan

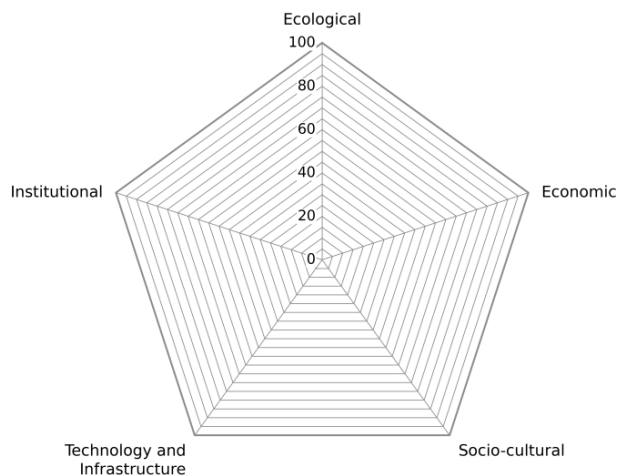
Source : Kavanagh dan Pitcher, 2004

Through this analysis method, it is possible to visualize the sustainability position using vertical and horizontal axes. The position of the point on the horizontal axis for sustainable development is given a score of 0, which means poor, and 100, which means good. If the index value is less than 50, it is considered unsustainable. See Figure 1 for further clarification:



Figure 1. Illustration of Determining the Sustainability Index of Hybrid Corn Farming (Pitcher and Preikshot, 2001)

Next, the sustainability index evaluation results for each dimension are depicted in the form of a kite diagram. Figure 2 shows the results of the sustainability index evaluation for each dimension (Pitcher and Preikshot, 2001).



Source : Pitcher dan Preikshot, 2001

Leverage and Monte Carlo Analysis

This Leverage analysis is used to determine the most sensitive attributes and the factors that influence the sustainability of hybrid corn. According to Dzikrillah et al. (2017), the determination of these attributes is based on changes in the root mean square (RMS) value on the x-axis. Monte Carlo analysis is needed for accuracy and validity testing due to potential errors in the ordination analysis

process (Fauzi & Anna, 2002). By using this method, the accuracy of the analysis can be assessed by determining the goodness of fit (satisfactory) if the R^2 value is greater than 80%, and greater than 100%. Additionally, a stress value of 0.25 means that a stress value below 25% is an acceptable tolerance for error.

Participatory Prospective Analysis

Prospective analysis is used to determine the important factors for the sustainability of hybrid corn farming. This analysis helps to identify, filter, and predict changes that occur with accurate and quick results, thus involving experts (Bourgeois and Jesus, 2004). To determine the important factors, the direct influence of one variable on another is first assessed. Therefore, the expert scores indicate the influence of each factor: a score of zero indicates no influence, a score of one indicates a small influence, a score of two indicates a moderate influence, and a score of three indicates a strong influence (Godet, 1999).

Therefore, it can be concluded that prospective analysis can be used to assess the main variables. Prospective analysis is used to determine the extent of the influence and the interrelationships between variables in the system.

Terhadap →	↓	A	B	C	D	E	F	G	H	I	J
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											

Source: Godet, 1999

Description: A – J: Important Factors in the System

Score	Description
0	No Influence
1	Small Influence
2	Moderate Influence
3	Very Strong Influence

Therefore, it can be concluded that prospective analysis can be used to assess the main variables. Prospective analysis is used to determine the extent of the influence and the interrelationships between variables in the system.

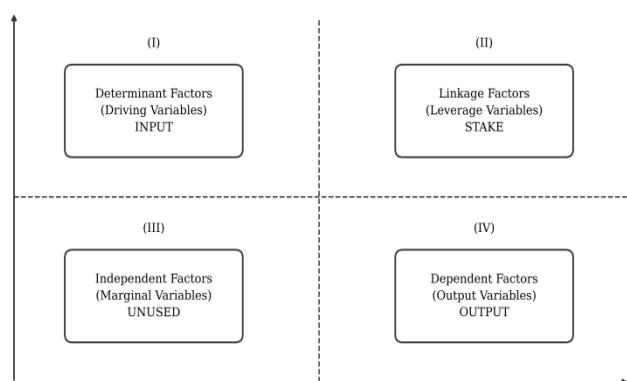


Figure 2. Level of Influence and Interdependence Between Factors in the System

Source: Bourgeois and Jesus, 2004

As stated by Bourgeois and Jesus (2004), the results obtained from various factors can be visualized in Figure 2, assuming the location of these factors is based on:

1. Quadrant One (Driving Variables)

Factors in this quadrant have a strong influence and low interconnection. These factors are the most significant determinants in the system and are known as driving factors.

2. Quadrant Two (Leverage Variables)

This quadrant indicates that the factors have a strong influence and a strong interdependence between factors (leverage variables). The factors in this quadrant are considered strong variables.

3. Quadrant Three (Marginal Variables)

This quadrant represents output factors (output variables), where the influence is small, but the interdependence is high.

4. Quadrant Four (Output Variables)

In this quadrant, marginal factors (marginal variables) are found, which have a small influence and low interdependence. These factors are independent within the system..

Result and Discussion

Characteristics of Hybrid Corn Farmers

The characteristics of hybrid corn farmers in South Bengkulu Regency consist of age, education, farming experience, and land area. Table 2 below provides a more detailed description of the characteristics of hybrid corn farmers.

Table 2. Characteristics of Hybrid Corn Farmers

No.	Information	Amount	Percent (%)	Average
1	Age			
	15-39	24	19.4	
	40-64	83	66.9	49.5
	>64	17	13.7	
2	Education			
	SD	42	33.9	
	Junior High School	31	25.0	9.3
	Senior High School	47	37.9	
	Bachelor of Degree	4	3.2	
3	Experience in Business			
	<5	43	34.7	
	5-10	50	40.3	8.6
	>10	31	25.0	
4	Land Area (Hectare)			
	< 0.5	20	16.1	
	0,5-1,0	93	75.0	0.7
	> 1,0	11	8.9	
5	Dependents			
	1-3	56	45.2	
	4-6	67	54.0	3.6
	>6	1	0.8	
6	Land Ownership Status			
	Rent	25	20.2	
	Ownership	96	77.4	ownership
	Profit sharing	3	2.4	

Source : Survai, 2023

Data Validity and Reliability Test

Validity Test

The technique used in this study is to compare the calculated correlation coefficient (rhitung) with the critical value (rtabel), where the sample size (N) is 124 and the degrees of freedom (DF) is 122, resulting in a critical value of 0.1484 at a 95% confidence level (0.05). The results of the test can be seen in Appendix 11 for further details. From these calculations, all statement items are considered valid as the calculated correlation coefficient (rhitung) is greater than the critical value (rtabel) of 0.1484. Therefore, all statement items in this research instrument are deemed valid for measuring data in the study of the sustainability of hybrid corn farming in South Bengkulu Regency.

Reliability Test

The reliability test is conducted by comparing the results of the SPSS output processing, where the minimum Cronbach's Alpha value is 0.6. For further clarity, the results can be seen in Table 8.

Tabel 1. Results of Fata Reliability Test

Cronbach's Alpha	N of Items
0.628	48

Based on the results of the reliability test, all statements in the instrument are considered usable as data measurement tools for this study, with a Cronbach's Alpha value of 0.628 for each attribute, which is greater than 0.6. According to Sugiyono (2012), the reliability coefficient is considered reliable if the value is at least 0.6.

Indeks dan Status Keberlanjutan Usahatani Jagung Hibrida

The sensitive attributes are influenced by the dimensions in the sustainability of hybrid corn farming. For each dimension, an analysis of the sustainability index and status is conducted on the respective dimensions: economic, socio-cultural, institutional, technology and infrastructure, and ecology. It is known that from the 5 sustainability dimensions, there are 9 attributes in the ecological dimension, 10 attributes in the economic dimension, 9 attributes in the socio-cultural dimension, 10 attributes in the technology and infrastructure dimension, and 10 attributes in the institutional dimension. Diagram 1 below shows a clearer illustration of the Hybrid Corn Farming Sustainability Index in Bengkulu Selatan as follows :

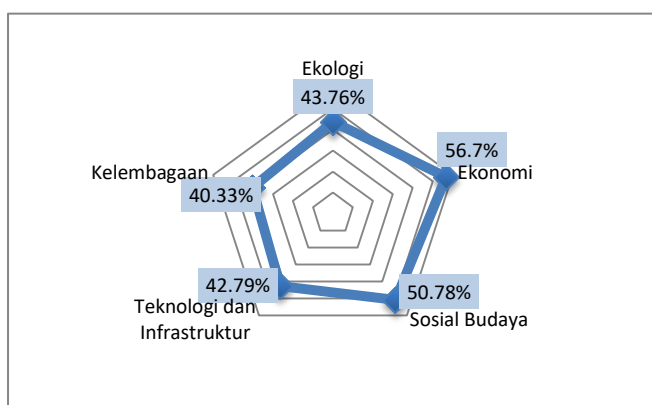


Diagram 1. Sustainability Index of Hybrid Corn Farming in South Bengkulu

Source: Primary Data, 2023

The analysis results from the five dimensions are as follows: the economic dimension at 56.70%, the socio-cultural dimension at 50.78%, the ecological dimension at 43.76%, the technology and infrastructure dimension at 42.79%, and the institutional dimension at 40.33%. Table 3

below explains the criteria for determining the sustainability index value of hybrid corn farming in Bengkulu Selatan.

Dimension	MDS (%)	Status Sustainability
Ecology	43,76	less sustainability
economic	56,70	moderate sustainability
Socio-Cultural	50,78	moderate sustainability
Technology and Infrastructure	42,79	Less sustainability
Institutional	40,33	Less sustainability
Multidimensional	46,87	Less Sustainability

Sumber: Data primer, diolah 2023

It can be concluded from Table 3 that the sustainability index results show that there are three dimensions with a status of low sustainability, namely the ecological dimension, technology and infrastructure, and institutional dimension. The other two dimensions, the economic dimension and socio-cultural dimension, have a status of being fairly sustainable. This is because the average productivity of hybrid corn farming in Bengkulu Selatan in 2021 was 5.51 tons/ha, which is lower than the average productivity of hybrid corn farming in Bengkulu Province at 6.03 tons/ha. Therefore, the lower average productivity results in insufficient supply of hybrid corn to meet the demand in Bengkulu Province (BPS Bengkulu Province, 2022).

To assess the error level in the MDS, a Monte Carlo analysis was conducted with a confidence level of 95%. This is in accordance with Sulaksono (2021), where in the MDS model, the researcher can estimate the magnitude of errors, and a Monte Carlo analysis is used to estimate the error level, applying a confidence level of 95%.

Dimension	MDS (%)	Monte Carlo (%)	Deviation (%)
Ecology	43,76	43,33	0,43
Economic	56,70	56,55	0,15
Socio-Cultural	50,78	50,65	0,13
Technology and Infrastructure	42,79	43,08	-0,29
Institutional	40,33	39,83	0,5
Multidimensi	46,87	46,69	0,184

Source: Primary Data, 2023

The Monte Carlo analysis test is used to examine the validity and stability of the index values. If, during the test, the index values do not show significant differences, it can be concluded that the index results have addressed random errors (Pitcher, 1999). The results of this analysis in the sustainability of hybrid corn farming indicate values that

differ significantly from the MDS results or the index values at a 95% confidence level. This discrepancy can be minimized by reducing the scores for each sustainability attribute.

Next, in Table 5, the Stress (S) value and R^2 are shown, which indicate the attributes discussed in the MDS analysis.

Statistical Parameters	Dimension				Average	
	Ecology	Economic	Socio-Cultural	Technology Infrastructure	and Institutional	
Stress	0,14	0,14	0,15	0,14	0,14	0,14
R^2	0,95	0,94	0,94	0,94	0,94	0,94

Source : Primary Data, 2023

The MDS analysis results show that all indicators assessed for the sustainability of hybrid maize farming provide good and reliable results. This is indicated by an average Stress value of 0.14 and an R^2 value of 0.94. According to Kavanagh and Pitcher (2004), if the Stress (S) value is less than 0.25 (25%) and the R^2 value is close to 1.0 (100%), the model is considered valid. The smaller the Stress value, the better the quality of the analysis (Sulaksono et al., 2021).

Ecology Dimension

Based on the MDS results, it is known that the ecological dimension of hybrid maize farming has a less sustainable category with a value of 43.76%. The obtained stress value is 0.14 and the R^2 value is 0.95. According to Kavanagh and Pitcher (2004), if the Stress (S) value is less than 0.25 (25%) and the R^2 value is close to 1.0 (100%), the model is considered valid. A more detailed explanation can be seen in Figure 3

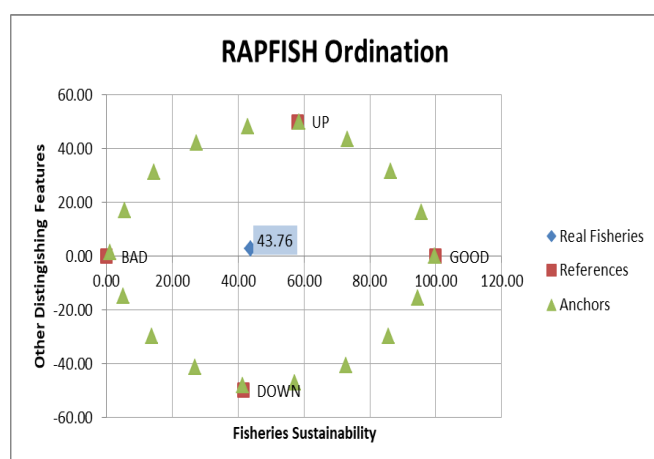


Figure 3. RAP-FISH Analysis Showing the Index Value

Next, a leverage analysis is conducted to identify the attributes that are sensitive to the ecological dimension, as shown in Figure 4. The goal is to enhance these attributes in the future. To determine the effectiveness and potential

impact of these attributes, further examination and improvement strategies are needed

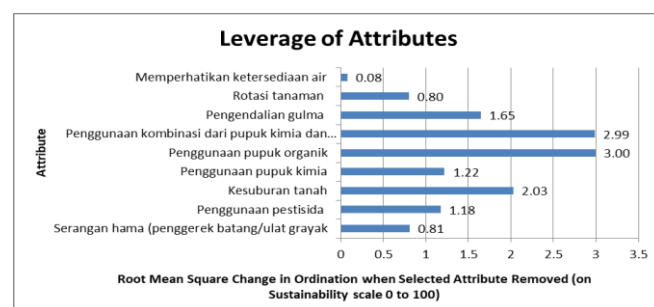


Figure 4. Sensitive Attributes of the Ecological Dimension

Based on the leverage results, there are 9 sustainability attributes within the ecological dimension. Out of the 9 attributes analyzed, 4 attributes have met the expected criteria, which are values greater than RMS and have positive values. These attributes are sensitive and dominant in influencing the sustainability of hybrid maize farming. These attributes are : Use of Organic Fertilizers (RMS = 3.00), Use of a Combination of Chemical and Organic Fertilizers (RMS = 2.99), Soil Fertility (RMS = 2.03), Weed Control (RMS = 1.65).

Economic Dimension

Based on the MDS results, it is found that the economic dimension of hybrid maize farming has a moderately sustainable category with a score of 56.70%, a stress value of 0.14, and an R^2 value of 0.94. According to Kavanagh and Pitcher (2004), the model will be considered valid if the stress value (S) is less than 0.25 (25%) and the R^2 value is close to 1.0 (100%). Therefore, it can be concluded that the economic dimension is valid and reliable. For further details, refer to Figure 5.

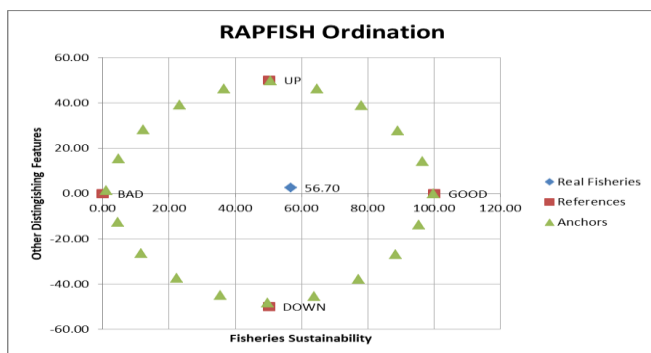


Figure 5. RAP-FISH Analysis Showing the Sustainability Index Value of the Economic Dimension

Next, a leverage analysis was conducted to identify the attributes that are sensitive to the economic dimension, as shown in Figure 6, with the expectation that these attributes can be improved in the future, leading to necessary improvements.

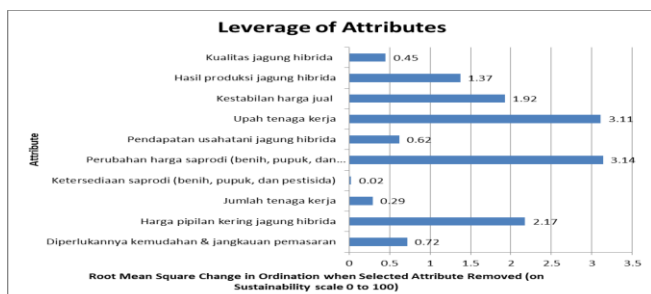


Figure 6. Sensitive Attributes of the Economic Dimension

Based on the leverage results for the sustainability of the economic dimension, out of the 10 attributes analyzed, there are 4 attributes that meet the expected criteria, with values greater than RMS and positive. These attributes are sensitive and dominant in influencing the sustainability of hybrid corn farming. These attributes include: (1) changes in the prices of production inputs (seeds, fertilizers, and pesticides) (RMS = 3.14), (2) labor wages (3.11), (3) price of hybrid corn dry kernels (2.17), and (4) price stability (1.92).

Socio-Cultural Dimension

Based on the MDS results, it is found that the socio-cultural dimension of hybrid corn farming has a category of "fairly sustainable" at 50.78%, with a stress value of 0.15 and an R2 value of 0.94. According to Kavanagh and Pitcher (2004), the model is considered valid if the stress value (S) is less than 0.25 (25%) and the R2 value approaches 1.0 (100%). Therefore, it can be concluded that the socio-cultural dimension is valid and can be accounted for, as shown in Figure 7.

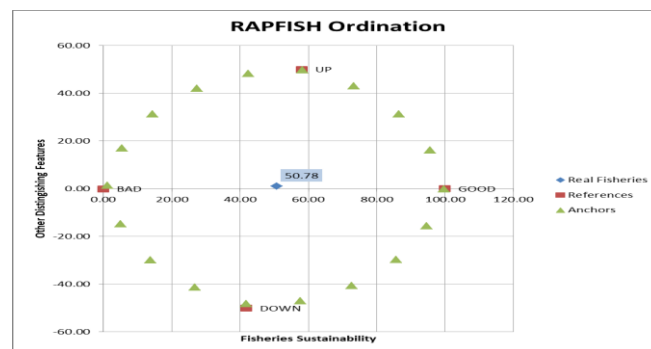


Figure 10. RAP-FISH Analysis Showing the Sustainability Index of the Socio-Cultural Dimension

Next, a leverage analysis is conducted to identify the attributes that are sensitive to the socio-cultural dimension, as shown in Figure 11. This analysis is performed with the expectation that these attributes can be improved in the future.

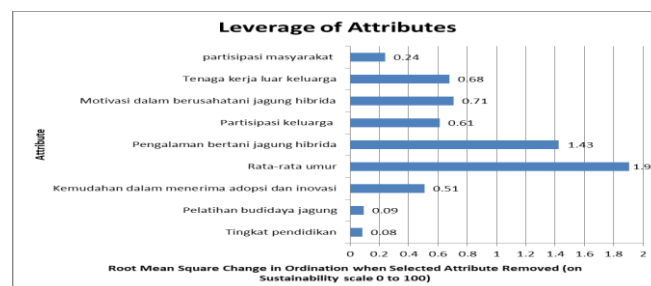


Figure 11. Sensitive Attributes of the Socio-Cultural Dimension

Based on the leverage results, from the 9 attributes analyzed in the socio-cultural dimension of hybrid corn farming sustainability, there are 2 attributes that meet the expected criteria, with values greater than RMS and positive, sensitive, and dominant in influencing the sustainability of hybrid corn farming. These attributes are : Average age (RMS = 1.90), Experience in hybrid corn farming (RMS = 1.43).

Technology And Infrastructure Dimension

Based on the MDS results, it is known that the technology and infrastructure dimension of hybrid corn farming has a sustainability category of 42.79%, with a stress value of 0.14 and an R2 value of 0.94. According to Kavanagh and Pitcher (2004), the model is considered valid if the Stress (S) value is less than 0.25 (25%) and the R2 value is close to 1.0 (100%). Therefore, it can be concluded that the technology and infrastructure dimension is valid and accountable, as shown in Figure 12.

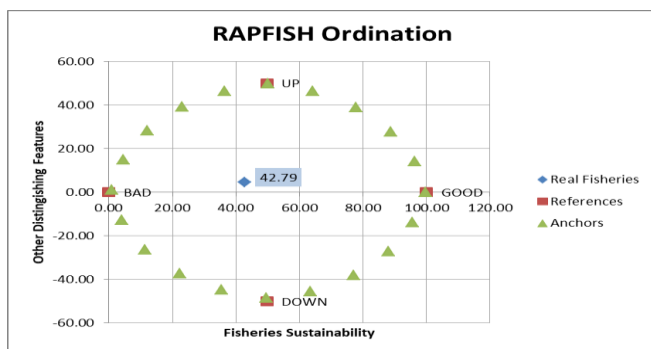


Figure 12. RAP-FISH Analysis Showing the Sustainability Index of the Technology and Infrastructure Dimension

Next, a leverage analysis was conducted to identify the sensitive attributes within the technology and infrastructure dimension, as shown in Figure 13. This analysis is performed with the expectation that it will help improve these attributes in the future.

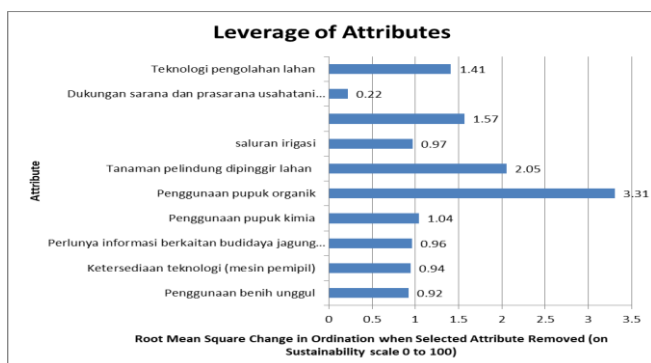


Figure 13. Sensitive Attributes of the Technology and Infrastructure Dimension

Based on the leverage results for the sustainability of the technology and infrastructure dimension, out of the 10 attributes analyzed, 2 attributes met the expected criteria, with values greater than RMS and positive, being sensitive and dominant in influencing the sustainability of hybrid corn farming. These attributes are : Use of organic fertilizers (RMS = 3.31), Protective crops at the edges of the land (RMS = 2.05).

Institutional Dimension

Based on the MDS results, it is found that the institutional dimension of hybrid corn farming has a sustainability category of 40.33%, with a stress value of 0.14 and an R2 value of 0.94. According to Kavanagh and Pitcher (2004), a model is considered feasible if the stress value (S) is less than 0.25 (25%) and the R2 value is close to 1.0 (100%). Therefore, it is concluded that the institutional dimension is feasible and can be accounted for, as shown in Figure 14.

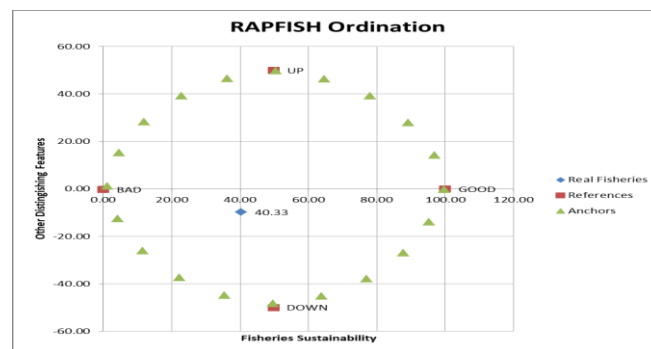


Figure 14. RAP-FISH Analysis Showing the Sustainability Index of the Institutional Dimension

Next, a leverage analysis is conducted to identify the attributes that are sensitive to the institutional dimension, as shown in Figure 15. This analysis is performed with the expectation that these attributes can be improved in the future.

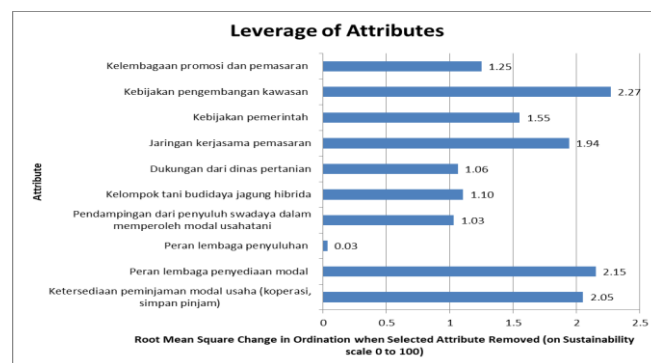


Figure 15. Sensitive Attributes of the Institutional Dimension

Based on the leverage analysis results, the sustainability of the institutional dimension, from the 10 attributes analyzed, shows that 5 attributes meet the expected criteria, with values greater than RMS and positive, sensitive, and dominant in influencing the sustainability of hybrid corn farming. These attributes are : Development policy for hybrid corn farming areas (RMS = 2.27), Role of institutions providing capital for hybrid corn farming (RMS = 2.15), Availability of business capital loans (cooperatives, savings and loans) (RMS = 2.05), Marketing collaboration network (RMS = 1.94), Government policy for hybrid corn farming (RMS = 1.55).

Sensitive Attributes Affecting the Sustainability of Hybrid Corn Farming

Based on the results of the MDS analysis, it is known that there are 16 sensitive attributes that influence the sustainability of hybrid corn farming in South Bengkulu Regency, namely:

No	Dimension	Attributes
1	Ecology	Use of organic fertilizer
		Use of a combination of chemical and organic fertilizers
		Soil fertility
		Weed control
2	Economic	Changes in the price of agricultural inputs (seeds, fertilizers, and pesticides)
		Labor wages
		Price of dry hybrid corn kernels
		Price stability
3	Socio-Cultural	Average age of farmers
		Experience in hybrid corn farming
4	Technology	Protective plants on the field's edge
5	Institutional	Development policies for hybrid corn farming areas
		Role of institutions providing capital for corn farming
		Availability of business capital loans (cooperatives, savings and loans)
		Marketing cooperation networks
		Government policies for hybrid corn farming

Source : Primary Data, 2023

Based on the results of the prospective analysis, visualized through a diagram of influence and interdependence among factors, as shown in Figure 16, nine key factors that have the greatest impact on the sustainability of hybrid corn farming in South Bengkulu Regency are identified. The factors that determine the

sustainability of hybrid corn farming are located in quadrant I after being analyzed using prospective analysis. The direct and indirect relationships can be arranged by placing each ordinate (x, y), as shown in Figure 16, as follows :

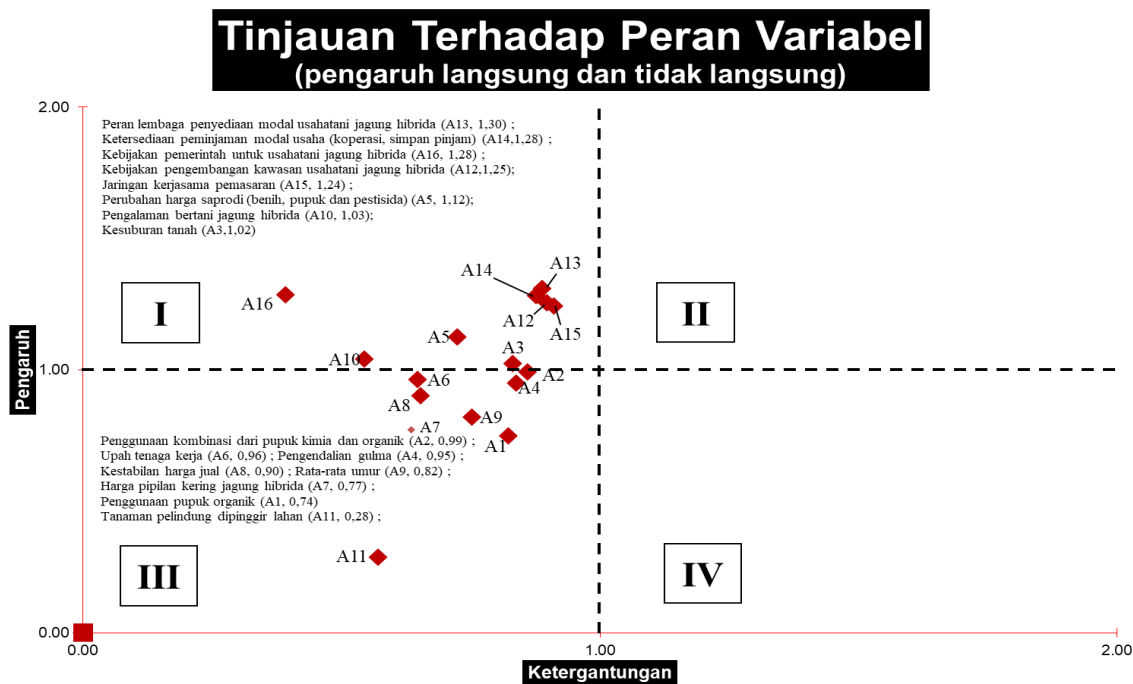


Figure 16. Analysis of Direct and Indirect Influences Between Attributes.

The upper-left quadrant (Quadrant I) represents the factors with the highest influence on the system's performance, with low interdependence between the factors. These factors are considered the key determinants in the system being studied and belong to the group of the most influential factors. The factors that have an impact on the sustainability of hybrid corn farming in South Bengkulu Regency include the role of institutions providing capital for hybrid corn farming, the availability of business capital loans (cooperatives, savings and loans), government policies for hybrid corn farming, policies for the development of hybrid corn farming, soil fertility, marketing cooperation networks, changes in input prices (seeds, fertilizers, and pesticides), experience in hybrid corn farming, and soil fertility.

Conclusions and Recommendations

Conclusion

Based on the results of the sustainability analysis of hybrid corn farming in South Bengkulu Regency using the Rap-Farm method, it can be concluded that :

1. Hybrid Corn Farming in South Bengkulu is Unsustainable: The hybrid corn farming system in South Bengkulu has a low sustainability score of 46.69%. Leverage analysis revealed 16 sensitive attributes that influence the sustainability of hybrid corn farming, with each dimension having distinct attributes.
2. Key Factors Influencing Sustainability: There are 8 key attributes identified through prospective analysis that have the strongest impact on the system's sustainability. These key attributes, among a total of 16, include: the role of financing institutions, the availability of business capital loans (cooperatives, savings and loans), government policies for hybrid corn farming, government policies for the development of hybrid corn farming, soil fertility, marketing cooperation networks, changes in the prices of production inputs (seeds, fertilizers, and pesticides), and farming experience. Soil fertility also appears as a critical factor influencing sustainability.

Suggestion

The recommendations that can be provided in this study are as follows :

1. Efforts should be made to improve the sustainability index of hybrid corn farming, which can be focused through cooperation networks such as partnering with poultry farmers. This can be achieved by providing more guidance to farmers through agricultural extension officers or local governments, and by educating the community on the importance of sustainable agricultural development, especially for hybrid corn cultivation.
2. Optimizing the key factors that influence the sustainability of hybrid corn farming in South Bengkulu

should be prioritized. Sustainability can be achieved by enhancing the role of financial institutions for capital provision, ensuring the availability of microloans (cooperatives, savings and loans), promoting government policies, improving input costs (seeds, fertilizers, and pesticides), maintaining soil fertility, expanding marketing cooperation networks, and increasing the farming experience in hybrid corn cultivation.

Reference

1. Anwar dan Muliati Galib. 2022. Analisis Multidimensi Keberlanjutan Tanaman Jagung (*Zea Mays L.*) Di Kecamatan Herlang Kabupaten Bulukumba. *Jurnal Pertanian Berkelanjutan*. 10 (1) : 71-84.
2. Alam, Samsul Fyka dan Sri Yuni Rahmawati. 2021. Analisis Manfaat Usahatani Jagung Pakan Ternak Terhadap Pendapatan Rumah Tangga Petani Jagung di Kecamatan Watopute Kabupaten Muna. *Prosiding Seminar Nasional*. 236-244.
3. Arbi, S. R. 2017. *Kontribusi Usahatani Jagung Terhadap Pendapatan Rumah Tangga Petani Di Desa Huidu Utara Kecamatan Limboto Barat Kabupaten Gorontalo*. Universitas Negeri Gorontalo. Skripsi. Publication Number 614412063.
4. Badan Pengkajian dan Pengembangan Kebijakan Perdagangan. 2017. *Potret Jagung Indonesia : Menuju Swasembada Tahun 2017*.
5. BPS Bengkulu Selatan. 2019. Bengkulu Selatan dalam Angka Tahun 2019. Bengkulu
6. BPS Provinsi Bengkulu. 2022. Provinsi Bengkulu dalam Angka Tahun 2022. Bengkulu
7. Dinas Pertanian Provinsi Bengkulu. 2022. Luas Panen, Produktivitas dan Produksi Berdasarkan Kabupaten/Kota di Provinsi Bengkulu Tahun 2017-2021.
8. Dzikrillah, G. F., Anwar, S., & Sutjahjo, S. H. (2017). Analisis Keberlanjutan Usahatani Padi Sawah di Kecamatan Soreang Kabupaten Bandung. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*. 7(2), 107–113
9. Fauzi, A., & Anna, S. 2002. Penilaian Depresiasi Sumberdaya Perikanan sebagai Bahan Pertimbangan Penentuan Kebijakan Pembangunan Perikanan. *Jurnal Pesisir Dan Lautan*. 4(2), 36–49.
10. Fauzi, A. dan S. Anna, 2005. *Pemodelan Sumber Daya Perikanan dan Lautan untuk Analisis Kebijakan*. Gramedia Pustaka Utama. Jakarta.
11. Joko, et al. 2022. Efisiensi Ekonomis Usahatani Jagung Di Kabupaten Kubu Raya. *Jurnal Ekonomi Pertanian dan Agribisnis (JEPA)*. 6(2) : 657-669.
12. Kavanagh, P. 2001. Rapid Appraisal of Fisheries (RAPFISH) Project. University of British Columbia, Fisheries Centre.

13. Kavanagh, P., & Pitcher, T. J. 2004. Implementing Microsoft Excel Software for Rapfish: A Technique for The Rapid Appraisal of Fisheries Status. *Fisheries Centre Research Reports*. 12(2), 1–75.
14. Mulyaningsih, Asih *et al.* 2018. Partisipasi Petani pada Gender Perspektif Kedelai dan, Jagung, Padi Usahatani. *Jurnal Penyuluhan*. 14 (1) : 145-158.
15. Muhammad, F. dan Rusthamrin H. Akuba. 2005. Agropolitan Inovasi Membangun Pertanian Departemen Pertanian.
16. Nazir, Moh. 2013. *Metode Penelitian Cetakan 8*. Bogor : Penerbit Ghalia Indonesia. 1-544
17. Nurmalina, R., 2008. Analisis Indeks dan Status Keberlanjutan Sistem Ketersediaan Beras di Beberapa Wilayah Indonesia. *Jurnal Agro Ekonomi*. 26(1) : 47-79.
18. Rukmana. 2010. *Jagung Budidaya, Pascapanen, dan penganekaragaman pangan*. Aneka Ilmu. CV. Semarang.
19. Risnawati H, *et al.* 2017. Analisis Keuntungan Petani Pada Usahatani Jagung Hibrida Di Desa Daenaa Kecamatan Limboto Barat Kabupaten Gorontalo. *Jurnal Agronesia*. 2(1) : 1-9.
20. Pitcher, T. J. and D. Preikshot. 2001. Rapfish: A Rapid Appraisal Technique to Evaluate The Sustainability Status of Fisheries. *Fisheries Research*. 49 (2001): 255-270.
21. Rao N. and Rogers P. 2006. Appraisal of Agricultural Sustainability. *Current Science*. 91(41): 439 – 448.
22. Saidah. 2011. Analisis keberlanjutan usaha tani hortikultura sayuran. *Jurnal Matematika, Sains dan Teknologi*. 12 (2) : 101-112.
23. Setimela, P.S., X. Mhike X, J.F. MacRobert, D. Muungani. 2006. *Maize Hybrids and Open-Pollinated Varieties: Seed Production Strategies*. In: *Strategies for*
- 27 Strengthening and Scaling up Community-based Seed Production*. Setimela PS and Kosina P (eds). CIMMYT FAO. Mexico DF (US).
24. Sinniati, *et al.* 2021. Strategi Pengembangan Agribisnis Jagung Di Desa Rajang Kecamatan Lembang Kabupaten Pinrang. Prosiding Semnas Politani Pangkep. Vol 2 : 418-438.
25. Sugiyono. 2010. *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R & D*. Bandung: Alfabeta.
26. Sugiyono. (2012). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.
27. Sulaksono, *et al.* Kajian Keberlanjutan Usaha Ternak Sapi Potong Di Kecamatan Air Napal Dan Kecamatan Batiknau Kabupaten Bengkulu Utara. *Jurnal Penelitian Pengelolaan Sumberdaya Alam dan Lingkungan*. 10 (2) : 426-439.
28. Tedjaningsih, Tenten *et al.* 2018. Peran Kelembagaan Dalam Pengembangan Agribisnis Mendong. *Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*. 4 (2) : 210-226.
29. Tim Karya Tani Mandiri. 2010. Pedoman Bertanam Jagung. CV. Nuansa Aulia. Bandung.
30. The World Bank. 2008. Program Nasional Pemberdayaan Masyarakat Mandiri Perkotaan. Jakarta: Salemba Empat.
31. Utami, P. P., Saputro, S. G., & Nikmatullah, D. 2016. Pendapatan dan Kesejahteraan Petani Jagung di Kecamatan Ketapang Kabupaten Lampung Selatan. Seminar Nasional Pertanian Peternakan Terpadu.
32. Zubaidah, Y., Z. Lamid, dan Ridwan. 2004. Prosiding Seminar Nasional Penerapan Agro Inovasi Mendukung Ketahanan Pangan dan Agribisnis. Puslitbang Sosial Ekonomi Pertanian Bogor: 214-219.