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Determining Factors of Porang Farming Sustainability in North Lombok Regency

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Abstract: The purpose of this study was to analyze the level of sustainability of porang farming based on five dimensions, including ecological, economic, social, technological and institutional dimensions and to analyze the factors that influence the sustainability of porang farming in North Lombok Regency. This study used a qualitative quantitative descriptive method with the unit of analysis being individual porang farmers in Bayan and Gangga Districts. The analysis used was the Multi Dimensional Scaling (MDS) method with Rap-PKLU using an approach modified from the RAPFISH program. Based on the results of the study, it is known that the level of sustainability of porang farming in the social dimension (81.68; sustainable), ecological dimension (74.80; quite sustainable), economic, technological and institutional dimensions (46.64; 43.47; 48.89; less sustainable). The determining factors that need to be considered to increase the index of the sustainability status of porang farming in each dimension are 1) ecological dimension: changes in land cover, porang plant care and diversity of shade plants; 2) economic dimension: diversification of income sources, stability of selling prices and economic growth; 3) social dimension: average age of farmers and land ownership status of agricultural businesses; 4) technological dimension: porang harvesting techniques, fertilization measures and post-harvest handling and 5) institutional dimension: cooperation with partners, agricultural extension workers, the existence of Microfinance Institutions (MFIs) and the intensity of group meetings.

Keywords: MDS; Porang; Sustainability

Introduction

Porang plants (Amorphophallus oncophyllus) are one of the tropical plants known to be able to live in various types and conditions of soil. Porang plants have begun to attract the attention of farmers in Indonesia, especially dry land farmers, because they have economic value. Based on previous research, porang contains glucomannan which acts as a cholesterol-lowering agent in the blood which is not widely known by the general public (Alamsyah, 2019). In addition, porang can also be used for food, cosmetics and industrial raw materials.

In recent years, there has been an increase in market demand to meet the needs of porang, namely as food ingredients, cosmetics and other industrial raw materials both in the domestic and foreign markets. According to Suheriyanto et al. (2012) in Sukartono et al. (2020) stated that the need for porang tubers for porang chips reached 3,400 tons. Amidst global economic challenges, the potential for porang cultivation outside Java is still wide open. On Lombok Island, porang has only been introduced as an intercrop in the agroforestry system. Porang cultivation was first developed in NTB in North Lombok Regency because the land and climate are suitable for the growth and development of porang.

Porang farming is spread across two sub-districts, namely Bayan Sub-district and Gangga Sub-district in North Lombok Regency. Porang cultivation began in 2017, where the amount of porang production in 2020 reached 6,087 tons with a land area of 304.35 ha. Each sub-district, namely Bayan Sub-district, is 3,665 tons while Gangga Sub-district is 2,422 tons involving 238 porang farmers (Hidayati et al., 2021).

In running a business, farmers face several obstacles such as not implementing a business orientation, lack of knowledge and skills in porang cultivation techniques and not optimal processing of production results and lack of cooperating investors.

To overcome these challenges, planned management is needed so that farming activities can be sustainable. One analytical approach that can be developed to assess the sustainability of porang farming is Multi-Dimensional Scaling (MDS). This approach is used to see the sustainability of farming in several dimensions, namely ecology, economy, social, technology and institutions. Several aspects of sustainability can be used as references for formulating

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policies in managing porang farming so that it is sustainable. Therefore, this study needs to be conducted considering that the sustainability of porang farming can bring better national porang development in the future. The purpose of this study is to analyze the level of sustainability of porang farming and analyze the factors that influence the sustainability of porang farming in North Lombok Regency.

Method

The method used is a qualitative quantitative descriptive method with data sources, namely primary data and secondary data. The research location is Bayan District and Gangga District in North Lombok Regency. The unit of analysis in this study is individual porang farmers in Bayan and Gangga Districts. The variables used are classified into five dimensions, namely ecology, economy, social, technology and institutions. Each dimension consists of several attributes and each attribute contains an assessment benchmark (bad-good). The analysis used to conduct this study is the Multi Dimensional Scaling (MDS) analysis with Rap-PKLU using a modified approach from the RAPFISH program.

This analysis will produce three outputs, namely ordination (MDS), leverage and monte carlo. Ordination analysis describes the sustainability status of porang farming in each dimension. Assume that if the index value is high, then porang farming is profitable (high level of sustainability). The following is a sustainability index scale categorized into 4 sustainability statuses, as shown in table 1.

Table 1. Index Categories and Sustainability Status

Index Value	Sustainability Status
0.00 – 25.00	Unsustainable
25.01 – 50.00	Less Sustainable
50.01 – 75.00	Sustainable Enough
75.01 – 100.00	Sustainable

Leverage analysis describes the most sensitive attributes in each dimension that can be a lever in increasing the sustainability index value. The most sensitive attributes can be seen through the root mean squared (RMS) where the greater the RMS value, the greater the role of the attribute in determining the sustainability index value.

Monte Carlo analysis shows how stable the ordination results (MDS) obtained are and helps identify errors in the assessment of attributes made by respondents. The Monte Carlo index value compared to the ordination index (MDS), stress value and determination coefficient R2 has a function to determine whether or not additional attributes are needed and reflects the accuracy of the dimensions studied with the actual situation. Stress values that are less than 0.25 (S <0.25) and R2 approaching 1 (100%) indicate that the analysis results are quite good.

Result and Discussion

Sustainability of Porang Farming Business

The level of sustainability of porang farming can be identified by considering ecological, economic, social, technological and institutional factors. The results of the Rap-PKLU multidimensional analysis showed that the social dimension has a sustainable status (81.68), the ecological dimension has a fairly sustainable status (74.80) and the economic, technological and institutional dimensions have a less sustainable status (46.64; 43.47; 48.89).

Ecological Dimension of Sustainability

Figure 1 shows the Rapfish ordination on the ecological dimension.

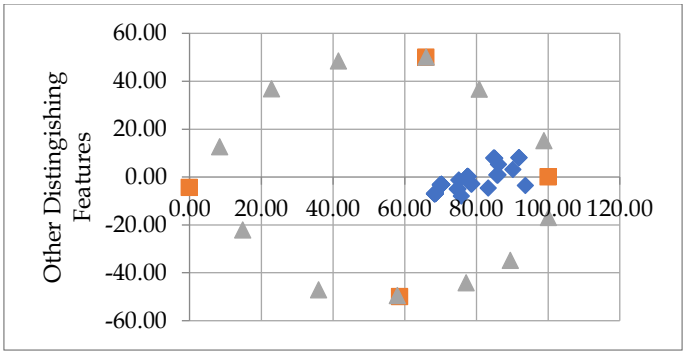

Figure 1. Analysis of the Sustainability Index of the Ecological Dimension of Porang Farming in North Lombok Regency

Figure 1 shows that the average value of the sustainability index of the ecological dimension of porang farming is in the range of (50.01 - 75.00) which is 74.80 with a fairly sustainable status. This means that porang farming in North Lombok Regency in the ecological dimension is quite sustainable at 74.8%.

In the leverage analysis, it can be seen that there are 7 attributes analyzed. Of all these attributes, there are 3 attributes with the highest RMS value or the most sensitive to the sustainability index, namely (1) land cover changes (3.48); (2) porang plant care (3.37) and (3) diversity of shade plants (3.35). The following are the results of the leverage analysis on the ecological dimension (Figure 2).

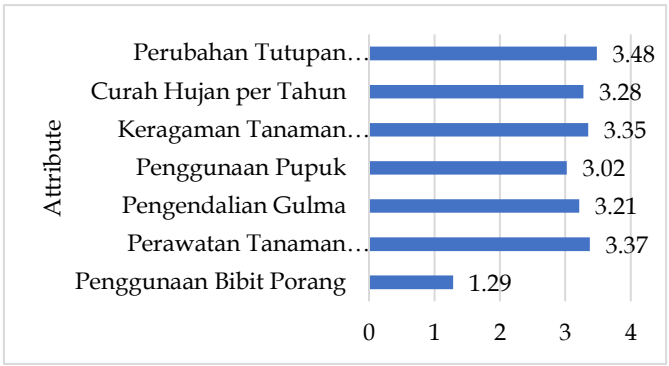

Figure 2. Leverage Analysis of Ecological Dimensions of Porang Farming in North Lombok Regency

In Figure 2, the most sensitive attribute with the highest RMS value of 3.48 is land cover change. In this study, changes in land cover, especially dry land, decreased, including open land, bushes/shrubs, secondary dry land forests and settlements. These areas were detected to have changed because the land cover in Bayan and Gangga Districts was used by the community, especially farmers, to cultivate agricultural commodities that do not require a lot of water, including plantation commodities such as coffee, coconut, cocoa, cashew nuts, durian, avocado and woody plants such as teak and mahogany trees. In addition, changes in land cover decreased when farmers cultivated porang plants because farmers did not need to cut down forests but porang could be planted between plantation crops or forest plants considering that porang is a food crop that is tolerant to shade.

The sensitive attribute with the second highest RMS value of 3.37 is porang plant care. In this study, farmers did not care for porang plants. This shows that farmers have not carried out agribusiness farming because porang plants are still supporting plants planted between plantation crops. In line with that, farmers do not apply chemical pesticides to porang plants because the requirement for exporting abroad is that they are free from chemical pesticides. According to one of the heads of a farmer group in Bayan District, buyers require that porang tubers be free from pesticides. In addition, the use of chemical pesticides can also increase control costs, increase the death of non-target organisms and can reduce environmental quality (Saputri et al, 2016).

The sensitive attribute with the third highest RMS value of 3.35 is the diversity of shade plants. In this study, porang farmers in Bayan and Gangga Districts, North Lombok Regency have a diversity of shade plants consisting of more than one type of plant, including coffee, chocolate, durian, cloves, cashew nuts, avocado, coconut and woody plants such as teak trees. Previous research stated that there are 3 shade plants that are suitable for porang plants, namely Arabica coffee, candlenut and chocolate plants. This is due to limiting factors that can be improved, namely the availability of water by harvesting rainwater and for slope boundaries, terraces can be made or parallel contour planting can be done (Sabariyah et al, 2023).

Sustainability Economic Dimension

Figure 3 shows the Rapfish ordination on the economic dimension. Figure 3 shows that the average value of the sustainability index of the economic dimension of porang farming is in the range of (25.01 - 50.00) which is 46.64 with a status of less sustainable. This means that porang farming in North Lombok Regency in the economic dimension is less sustainable by 46.64%.

In the leverage analysis, it can be seen that there are 9 attributes analyzed. Of all these attributes, there are 3 attributes with the highest RMS value or the most sensitive to the sustainability index, namely (1) diversification of income sources (7.19); (2) stability of selling prices (6.19) and (3) economic growth (6.14). The following are the results of the leverage analysis on the economic dimension (Figure 4).

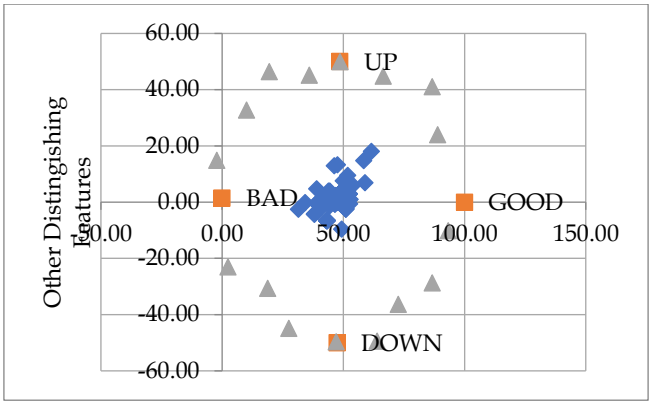

Figure 3. Analysis of the Sustainability Index of the Economic Dimension of Porang Farming in North Lombok Regency

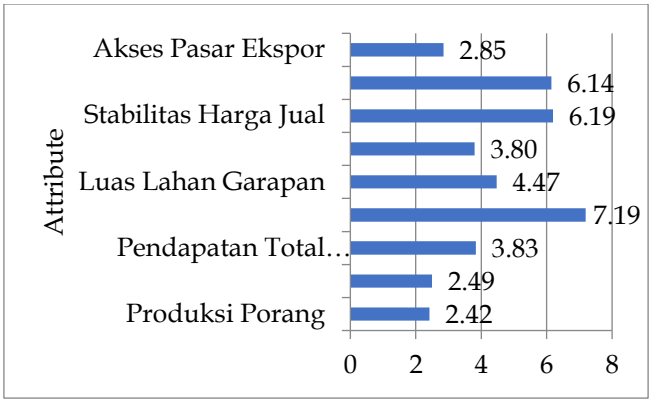

Figure 4. Leverage Analysis of the Economic Dimension of Porang Farming in North Lombok Regency

In Figure 4, the most sensitive attribute with the highest RMS value of 7.19 is diversification of farming businesses which focuses on developing various types of businesses in the agricultural sector which aims to reduce risks related to fluctuations in commodity selling prices, increase income and increase local food security. In this study, farmers in Bayan and Gangga Districts who cultivate porang are expected to be able to utilize the gaps and shade of plantation crops so that they can reduce dependence on plantation commodities. This is because porang is an export crop that has many benefits, namely as an industrial raw material and high glucomannan content. So this is an opportunity for farmers to increase income and reduce risks in farming (Hidayat, 2023).

The second most sensitive attribute with the second highest RMS value of 6.19 is selling price stability. In this study, the porang commodity experienced quite significant price changes where the changes occurred in less than 3 years. At the time of the study, farmers stated that the selling price of porang tubers was in the range of 2,500-3,000/kg. In 2020, the price of porang tubers

reached 12,000/kg (Maulidyani, 2023). Bahtiar (2022) stated that food price fluctuations were caused by commodity supply, increased demand for commodities, import restriction policies and international demand. This is supported by a statement from one of the companies, namely PT Asia Prima Konjac, which stated that the decline in the price of porang was due to China closing access to porang exports from Indonesia for two years. Another reason is related to food safety so that efforts are needed to improve the quality of porang so that it can be accepted. In line with that, porang farmers in Bayan and Gangga Districts have tried to improve the quality of porang by not using a mixture of chemical fertilizers in order to meet the qualifications for export abroad.

The third most sensitive attribute with the third highest RMS value of 6.14 is economic growth. This attribute is one of the indicators to see the real level of the economy in a region and can be measured using GRDP (Gross Regional Domestic Product). In 2020 - 2023, the economic growth of North Lombok Regency experienced a significant increase. Judging from the 2010 Constant Price GRDP, the agricultural industry (one of the porang), forestry and fisheries have values that continue to increase and the highest value is in 2023 of 1,229.11 billion rupiah. Naraswari et al (2023) stated that the increase in GRDP also contributed to increasing PAD revenues through increasing community income from the economic sector.

Social Dimension of Sustainability

Figure 5 shows the Rapfish ordination on the social dimension.

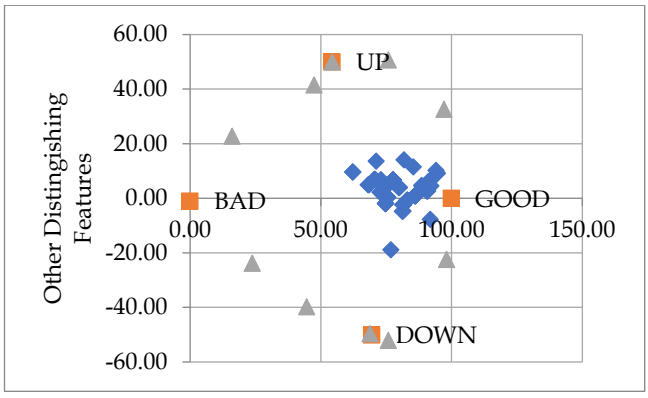

Figure 5. Analysis of the Sustainability Index of the Social Dimension of Porang Farming in North Lombok Regency

Figure 5 shows that the average value of the social dimension of the porang farming sustainability index is in the range of (75.01 - 100.00) which is 81.68 with sustainable status. This means that porang farming in North Lombok Regency in the social dimension is sustainable by 81.68%.

In the leverage analysis, it can be seen that there are 6 attributes analyzed. Of all these attributes, there are 2 attributes with the highest RMS value or the most sensitive to the sustainability index, namely (1) the average age of farmers (10.18) and (2) the status of ownership of agricultural land (6.21). The following are the results of the leverage analysis on the social dimension (Figure 6).

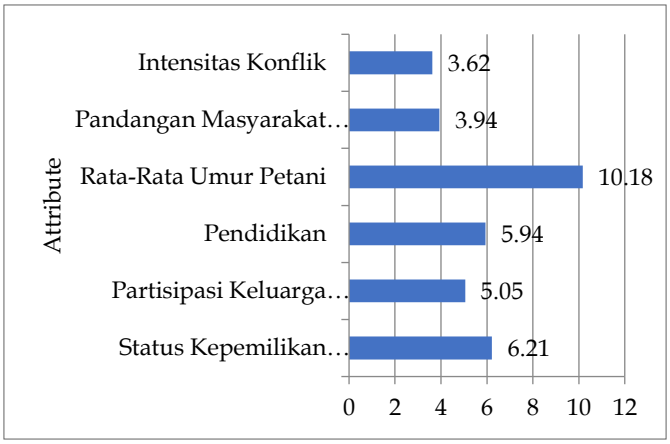

Figure 6. Leverage Analysis of Social Dimensions of Porang Farming in North Lombok Regency

In Figure 6, the most sensitive attribute with the highest RMS value of 10.18 is the average age of farmers. In this study, the average age of porang farmers in Bayan District was in the range of 26-45 years where this age range is the productive age. Productive age affects the mindset in making decisions about various things in farming. Burano (2019) stated that younger farmers tend to be more innovative, motivated and dare to take risks. Based on research, quite a lot of young farmers choose to farm porang by looking at market demand and are more open to plants with high economic value.

The second most sensitive attribute with the second highest RMS value of 6.21 is the status of farm land ownership. In this study, the status of porang farm land ownership in Bayan and Gangga Districts is self-owned, profit sharing and HKm. The majority of farmers cultivate or work on their own land. Farmers with their own land tend not to take into account land rental costs so that they affect farming costs. In addition, farmers can also determine the diversity of farming businesses that include the level of productivity, income and expenses for land (Mudakir, 2011). Ownership of their own land affects the sustainability of porang farming because farmers can easily make decisions to plant porang based on income levels, cultivation that is not too difficult and optimizing interspersed land.

Sustainability of Technology Dimension

Figure 7 shows the Rapfish ordination on the technology dimension. Figure 7 shows that the average value of the sustainability index of porang farming in the technology dimension is in the range (25.01 - 50.00) which is 43.47 with a status of less sustainable. This means that porang farming in North Lombok Regency in the technology dimension is less sustainable by 43.47%.

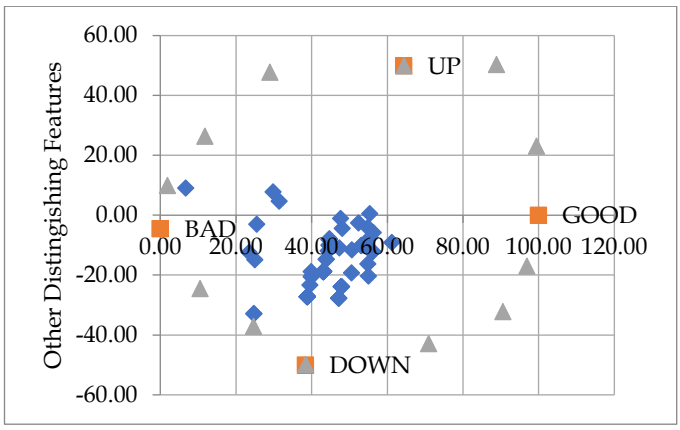

Figure 7. Analysis of the Sustainability Index of the Technology Dimension of Porang Farming in North Lombok Regency

In the leverage analysis, it can be seen that there are 7 attributes analyzed. Of all these attributes, there are 3 attributes with the highest RMS value or the most sensitive to the sustainability index, namely (1) porang harvesting technique (9.29); (2) fertilization actions (8.06) and (3) post-harvest handling (8.04). The following are the results of the leverage analysis on the technology dimension (Figure 8).

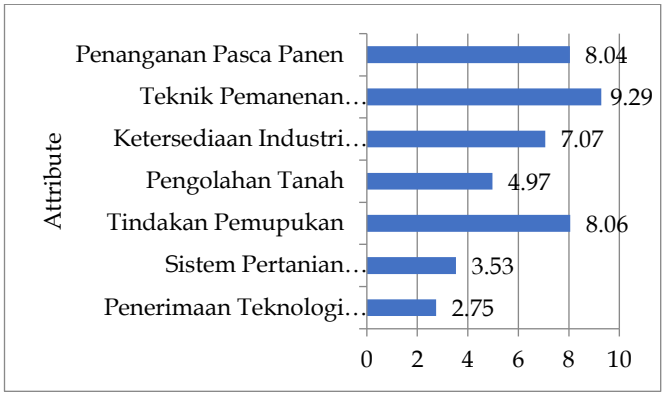

Figure 8. Leverage Analysis of Technology Dimensions of Porang Farming in North Lombok Regency

In Figure 8, the most sensitive attribute with the highest RMS value of 9.29 is the porang harvesting technique. In this study, porang farmers harvested in Bayan District, namely taking tubers in the soil produced by porang plants by digging them with a hoe rather than pulling them out directly. Before digging, farmers marked the porang plants to avoid damage to the porang tubers during the digging process (Febrianti et al, 2023). Harvesting using the digging technique is carried out because the right time to harvest porang tubers is in the dry season which coincides with the dormant period or rest period where the leaves will wilt and dry as if they were dead so that the price of porang tubers tends to be higher (Ningrum and Marina, 2022).

The second most sensitive attribute with the second highest RMS value of 8.06 is fertilization. Porang farmers in Bayan and Gangga Districts do not fertilize. Farmers do not provide fertilizer to porang plants considering that porang tubers are one of the agricultural commodities exported abroad where the destination countries for porang exports require porang tubers to be free of chemical content. However, porang farmers can apply the concept of organic cultivation by utilizing manure in the local community. Previously, manure needs to be fermented so that it can be utilized by plants for their growth properly and does not have a bad effect on the formation and growth of tubers (Sumarwoto et al, 2020). Fertilization can be done when it is first planted, namely basic fertilization when the soil is loosened and then fertilization can be done once a year (at the beginning of the rainy season) (Ningrum and Marina, 2022).

The third most sensitive attribute with the third highest RMS value of 8.04 is post-harvest handling. In this study, post-harvest handling of porang farmers in Bayan and Gangga Districts is still quite simple, namely porang tubers after being harvested are cleaned from dirt that is still sticky, packaged and selected according to size. The smallest size of porang tubers is 1 kg and is adjusted to the size of other porang tubers. Porang farmers still cannot carry out post-harvest processing because they are not familiar with the technology to remove toxins in coarse porang flour individually, so farmers choose to sell them directly to collectors in the form of fresh porang tubers.

Institutional Dimension Sustainability

Figure 9 shows the Rapfish ordination on the institutional dimension.

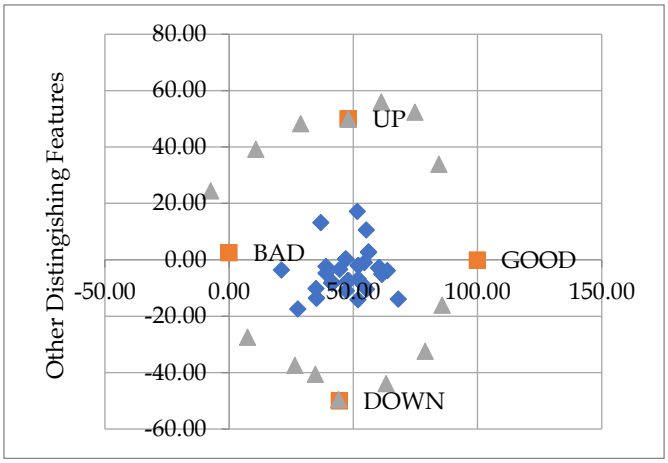

Figure 9. Analysis of the Sustainability Index of the Institutional Dimension of Porang Farming Business in North Lombok Regency

Figure 9 shows that the average value of the sustainability index of the institutional dimension of porang farming is in the range of (25.01 - 50.00) which is 48.89 with a status of less sustainable. This means that porang farming in North Lombok Regency in the institutional dimension is less sustainable by 48.89%. In the leverage analysis, it can be seen that there are 8 attributes analyzed. Of all these attributes, there are 4 attributes with the highest RMS value or the most

sensitive to the sustainability index, namely (1) cooperation with partners (7.59); (2) agricultural extension workers (6.98); (3) the existence of Microfinance Institutions (MFIs) (6.77) and (4) intensity of group meetings (6.26). The following are the results of the leverage analysis on the institutional dimension (Figure 10).

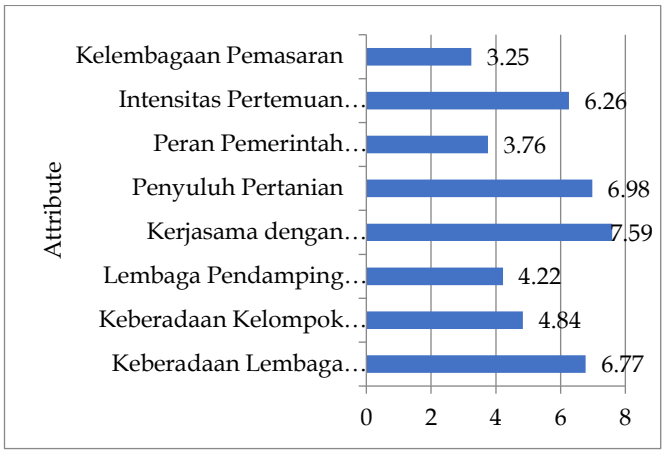

Figure 10. Leverage Analysis of Institutional Dimensions of Porang Farming Business in North Lombok Regency

In Figure 10, the most sensitive attribute with the highest RMS value of 7.59 is cooperation with partners. In this study, partners who have collaborated with porang farmers include the Berkah Gumi Lombok Cooperative, PT. Astra International and Mataram University. Porang farmers in Bayan and Gangga Districts have collaborated with these partners but there has been no follow-up until now. This is due to obstacles related to the uncertainty of the price of porang commodities which will be related to the uncertainty of the profits obtained by farmers. So farmers tend to wait and hold back so as not to harvest which results in a decrease in the availability of porang raw materials. If the partnership runs continuously, it can provide many benefits including economic benefits and technical benefits for farmers. Economically, farmers get market certainty so that they have no difficulty in selling porang production. While technically farmers get farming facilities such as assistance with seeds and tools to improve farming and get increased human resources (HR) such as business management training, cultivation technology and post-harvest technology (Rohmaya et al, 2023).

The second most sensitive attribute with the second highest RMS value of 6.98 is agricultural extension workers. In this study, agricultural extension workers in Bayan and Gangga Districts visited porang farmers only once a month. The visit of agricultural extension workers is considered lacking because they have not been optimal in providing socialization related to porang plants. Farmers cultivate porang because of their own initiative and seeing other farmers. However, this is in contrast to the statement of the extension worker where the government has not regulated policies on porang commodities so that agricultural extension workers are still confused about providing assistance to farmers regarding porang plants. Extension is one strategy to improve farmers' abilities in the aspects of cultivation, processing and marketing for agricultural development in North Lombok Regency (Rahayuningsih, 2020).

The third most sensitive attribute with the third highest RMS value of 6.77 is the existence of Microfinance Institutions (MFIs). In Bayan and Gangga Districts, there are no microfinance institutions that function to provide business capital loans, provide savings services and manage community funds. MFIs play an important role in the development of MSMEs because they help small and medium entrepreneurs with banking services. MFIs also increase community productivity, especially porang farmers, and can help farmers manage their finances. Meanwhile, some farmers have difficulty in capital so that if MFIs can be formed and run well in Bayan and Gangga Districts, farmers will get access to capital assistance to farm porang (Yasin et al, 2021).

The fourth most sensitive attribute with the fourth highest RMS value of 6.26 is farmer group meetings. In this study, farmer group meetings in Bayan and Gangga Districts were routinely held 2-3 times per month. This meeting was held to reach an agreement on problems and interests in farming. Farmer involvement in farmer groups in Bayan and Gangga Districts was quite active where farmers shared information on cultivation methods, marketing and prices. In addition, farmers also agreed not to harvest if the price offered was not appropriate. This shows that farmer groups play an important role in increasing agricultural productivity by implementing technology, building farmer knowledge and skills and strengthening farmers' bargaining position (Sa'diyah and Dyanasari, 2016).

Monte Carlo Analysis

Analysis*monte carlo*conducted to assess the uncertainty of each dimension in MDS. Monte Carlo results show that the level of confidence is 95% where each dimension does not have much difference (relatively small difference). The difference or gap in the sustainability index values between Monte Carlo MDS is shown in table 2 below.

Table 2. Differences in Sustainability Index between Rap-PKLU and Monte Carlo

Status Index	MDS	Monte Carlo	Difference
Ecology	74.80	73.85	0.95
Economy	46.64	46.76	0.12
Social	81.68	78.07	3.61
Technology	43.47	43.80	0.33
Institutional	48.89	48.77	0.12

In Table 2 it can be seen that the difference or gap between the MDS and Monte Carlo sustainability indices is relatively small, ranging from 0.12 to 3.61. This means

that the level of analysis error using Rap-PKLU is relatively small, ranging from below 4%, so it can be said that the Rap-PKLU method is good enough as an evaluation of porang farming development in North Lombok Regency. The following is a table containing the stress and R2 values for each dimension listed in table 3.

Table 3. Stress Value and R2 of Porang Farming Sustainability Dimensions in North Lombok Regency

Dimensions of Sustainability	Parameter	
	Stress	R2
Ecology	0.22	0.94
Economy	0.15	0.96
Social	0.20	0.93
Technology	0.19	0.94
Institutional	0.18	0.92

In Table 3 it can be seen that the value*stress*each dimension ranges from 0.15 - 0.20 which states that the stress value is less than 0.25, meaning that the analysis error is relatively low and therefore considered acceptable. Likewise with R2 which can be seen in table 3 with each dimension ranging from 0.92 - 0.96 which states that the Rap-PKLU model is quite accurate in representing the data analyzed. The resulting R2 value is close to 1, meaning that the number of attributes used is sufficient to reflect the actual sustainability conditions.

Conclusion

The sustainability status of porang farming in North Lombok Regency is included in the fairly sustainable category with an average index value of 59.10. The sustainability index values for each dimension, namely the ecological, economic, social, technological, institutional dimensions, are 74.80; 46.64; 81.68; 43.47; and 48.89.

The determining factors that need to be considered to improve the sustainability status index of porang farming in North Lombok Regency in each dimension are 1) ecological dimension: changes in land cover, porang plant care and diversity of shade plants; 2) economic dimension: diversification of income sources, stability of selling prices, and economic growth; 3) social dimension: average age of farmers and land ownership status of farming; 4) technological dimension: porang harvesting techniques, fertilization measures and post-harvest handling and 5) institutional dimension: cooperation with partners, agricultural extension workers, the existence of Microfinance Institutions (MFIs) and the intensity of group meetings.

Author Contributions
All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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