SUSTAINABILITY ANALYSIS OF INTEGRATED FARMING BUSINESS MODELS OF FOOD CROP AND BEEF CATTLE

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SUSTAINABILITY ANALYSIS OF INTEGRATED FARMING BUSINESS MODELS OF FOOD CROP AND BEEF CATTLE

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Abstract. Generally, beef cattle and food crop business are still being diversified and have not implemented yet in integrated farming. From those reason above, we need a model of integration of beef cattle and crop Systems (SISPOTTA), namely farming systems that was integrate between beef cattle business with crops as an effort to develop sustainable livestock, especially for areas with irrigation fields. Purpose of this research was to analyze the sustainability status of economic dimension, ecology, technology, social and institution of the integrated system of cattle business and crop farming in irrigation fields. Determination location of this research was carried out based on the Multistage Sampling Method, each location was carried out by Purpose Sampling. Jember district was chosen as the location of this research, because from the previous survey information showed that Jember district had a rice field area used a technical irrigation system so those field can applied a cropping pattern model within one year with rice plants and other food crops such as corn, and soybeans. Besides, farmers are accustomed to raising cattle, especially beef cattle additional activities besides crop farming. This research conducted from November 2016 to April 2017. Sustainability Analysis with M Rap-Sispotta as the data Analysis of this research. Based on the five existing dimensions, the results showed that the agribusiness integration system of cattle and crops in this research area has a sustainability index value of 42.40. This index showed that agribusiness is still less sustainable. The dimensions that have the worst sustainability index and need to be taken seriously at are technology and infrastructure dimensions, also law and institutional dimensions.

1. Introduction

To be able to increase farmers' income is by implementing integrated farming systems, namely by combining food crop farming with the beef cattle business. The integrated farming system is defined as the incorporation of all agricultural components in an integrated agricultural business system. The purpose of implementing this system is to suppress minimum input from the outside (low input) so that the negative impacts are maximally avoidable and sustainable.

Integration between plants and livestock has actually taken root in the pattern of smallholder agriculture for a long time and is part of farmer farming. In a conventional farming system, livestock is a supporting element that is treated as savings. Distortion of conventional systems began to occur along with the increasing population and the narrowing of agricultural land, as well as increasing business cultu

The integration between food crops and beef cattle is a combination of two commodities that can be developed simultaneously in the same area, where each of them needs each other. Plants will produce agricultural waste that can be used as animal feed. While beef cattle are animals that can produce, potential manure that can be used for fertilizer crops and improve the physical properties of the soil. With the fulfillment of one input facility, especially feed for beef cattle and organic fertilizer

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for food crops, it is hoped that this will reduce production costs and increase the production of food crops and livestock. This will ultimately increase the income and welfare of farmers and support the food and meat self-sufficiency program in Indonesia.

The application of a sustainable agricultural system can be used as a momentum to encourage the development of the people's economy. Farmers are very ready to accept sustainable farming systems because the inputs used are available in the surrounding natural environment. Even before recognizing the intensification of agriculture by using chemical fertilizers and pesticides, farmers have implemented environmentally friendly sustainable farming systems, for example by using manure. With traditional knowledge possessed, farmers need to be empowered so that they have increased knowledge about sustainable agriculture and understand the opportunities and demands of the market that want quality and environmentally friendly products. Thus, farmers can produce high economic value agricultural products while being able to preserve environmental functions [1].

According to [2] sustainable agriculture (sustainable agriculture) is the management of agricultural resources to meet changing human needs while maintaining or improving environmental quality and preserving natural resources. Furthermore, he said, the aim of farmer households in managing farming is; productivity, security, continuity, and identity. Conway (1987) in [3] said the same thing, it needs rearrangement in the form of integration to multiple uses that are ecosystem-minded even though the insight of agro-ecosystem is complex and complex management, but the most important specific characteristics concern the four points. The four principal properties are the evenness (*equitability*), sustainability (*sustainability*), stability (*stability*) and productivity (*productivity*).

2. Research Method.

This study was conducted in the Jember Regency area intentionally (purposive) with the consideration that the area is one of the extensive technical irrigated rice fields and has the potential to develop beef cattle. In addition, the condition of the local community has become accustomed to raising beef cattle and rice farming.

Samples taken were farmers who had food crop farming cultivated in technical irrigated rice fields, and kept beef cattle at least 1 (one) year, and had experience in raising cattle for a minimum of 3 (three) years.

The sustainability analysis method uses a modification of the Rap-SISPOTTA method (SISPOTTA modified). [4] explain that Rap-SISPOTTA is a new method multi-disciplinary rapid appraisal for evaluating sustainability. Sustainability measurements are based on 3-5 dimensions or aspects of sustainable metrics according to the instructions of [5] and [6], namely economical dimensions, ecological/environmental dimensions, technical dimensions (technical), the institutional dimensions (institutional) and social dimensions (sociological). The number of attributes used in this study can be seen in Table 1.

Table 1 Amount of Attributes for Each Sustainability Dimension.

No.	Dimension	Amount of Attributes
1	Ecological	20
2	Economical	15
3	Technology and Infrastructure	12
4	Sociocultural	14
5	Legal and institutional	8
	Total	69

The value of each attribute of each economic, ecological, technological, social and institutional dimension is based on the data obtained through interviews and field observations (primary data) and through literature studies (secondary data) which Multidimensional Scaling (MDS)

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will analyze. The entire attribute value of each dimension is included in the application program Microsoft Excel, then MDS analysis using the Excel for Rap-SISPOTTA application, where the application of this analysis will be carried out the analysis of feasibility and significance tests, analysis of sustainability status, and sustainability model simulation analysis.

a. Feasibility Test and Significance of the Sustainability Model.

The feasibility test of a sustainability model is carried out by measuring the goodness of fit from the distance of the estimation point with the origin through the calculation of S-Stress. The technique used to determine the goodness of fit is done by the method least square that is based on the root of Euclidean distance (squared distance) or called the algorithm of scale (ALSCAL). ALSCAL method optimized squareddistance to the square of the origin (O_{ijk}), and then the S-Stress value is calculated based on the formula as follows:

$$S = \sqrt{\frac{1}{m}\sum_{k=1}^{m}\left[\frac{\Sigma_i\Sigma_j\,(d^2_{ijk} - O^2_{ijk})^2}{\Sigma_i\Sigma_j\,O^4_{ijk}}\right]}$$

Goodness of fit in MDS is a measure of how well the point can reflect the original data, which is determined by the value of S-Stress resulting from the calculation of the S value. The goodnessoffit MDS analysis is determined by the value of the S-Stress resulting from the calculation, where the low stress values showed high goodness, while the value of S high indicate otherwise. In RAP-SISPOTTA modified from Rap-SISPOTTA, a good model is indicated by a valuestress smaller than 0.25 and vice versa if the value stress is higher than 0.25, the MDS results have low accuracy.

Research [4] and [6], explain that the results of Multidimensional Scaling (MDS) analysis are then compared with the results of analysis Monte Carlo (MC), where the results of comparison if the differences are small then indicate that the impact of scoring errors is relatively small, the impact of some variations in giving scores to attributes are relatively small, evaluation with MDS that is repeated becomes stable, data errors or data loss becomes relatively small. Comparing the results of MC analysis and MDS analysis at 95% confidence level or 5% error rate so that the difference in the value of the analysis is greater (MC-MDS> 5%) or smaller (MC-MDS <5%) If the value of the difference between the two analyzes is> 5% then the results of the MDS analysis are inadequate as estimators of the sustainability index value, and if the difference between the two analyzes is <5%, the MDS analysis results are sufficient to estimate the sustainability index value. Modified Rap-SISPOTTA also takes into account aspects of uncertainty and is analyzed using analysis techniques Monte Carlo. This uncertainty caused by:

1) The impact of errors in scoring due to lack of information.
2) Impact of diversity in scoring due to differences in assessment.
3) Data entry error.
4) The high stress value obtained from the ALSCAL algorithm.

Analysis *Monte Carlo* is also a simulation method to evaluate the impact of random *errors in* the analysis of all attributes of each dimension. In this case, analysis is *Monte Carlo* done by a method *scatter plot* that shows the orientation of each dimension.

[6] explain that with the modification of the method *Rap-SISPOTTA (modified SISPOTTA)*, observed objects are based on two to five dimensions, so the ordination technique in MDS is based on *Euclidean Distance* in dimensions of n . For this study using five dimensions with the following formula:

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$$d = \sqrt{\{(V_1-V_2)^2 + (W_1-W_2)^2 + (X_1-X_2)^2 + (Y_1-Y_2)^2 + (Z_1-Z_2)^2\}}$$

The significance test in the sustainability model based on the configuration or coordination of an object or point in MDS is approximated by re-expressing the distance *Euclidean* (d_{ij}) from point I to point j with the origin (δ_y) with equation:

$$d_{ijk} = \alpha + \beta\delta_{ij} + \acute{\varepsilon}$$

The square distance is the distance *Euclidean* given weighting or written with

$$d^2_{ijk} = \Sigma_{a=1} \; W_{ka} \; (x_{ia} - x_{ja})^{\,2}$$

Determinants of significance can be seen from the processed RAP-SISPOTTA with the *Root Means Square* (RMS) highest (maximum) value up to half the value of each dimension of sustainability, where Kavanagh and Pitcher (2004) explain that the advantage factor is attributes whose existence has a sensitive effect on increasing or decreasing sustainability status. The greater the RMS value, the greater the significance or role of these attributes to the sensitivity of sustainability status.

b). Sustainability status assessment.

The assessment of the overall attributes of each dimension of sustainability in the agribusiness integration system of beef cattle with horticultural crops is categorized into the categories of good, good enough, poor and bad status. The assumption that performance lies between 0 to 100% or bad to excellent. Among the bad to good grades, there are intervals of performance values that are sufficient and lacking, so that there are four levels of performance that are bad, lacking, moderate and good, so that the intervals of 0.25%, 50%, 75% and 100% are obtained.

The results of the assessment of the performance of attributes of each dimension are mapped into two reference points which are bad and good, and the performance level is divided into 4 (four) categories of attribute research results, as stated by [4] and [6] can be seen in Table 2.

Table 2. Categories of Sustainability Status.

No.	Dimension Index	Category	Description
1	00,00 -24,99	Bad	Not Sustainable
2	25,00 – 49, 99	Lacking	Less Sustainable
3	50,00 – 74,99	Enough	Quite Sustainable
4	75,00 – 100,00	Good	Sustainable

Source: Kavanagh and Pitcher (2004).

3. Results And Discussion

The Summary results from the *MDS-Rap-SISPOTTA analysis* for the five dimensions are presented in Table 3.

Table3. Summary of *MDS-Rap-SISPOTTA* analysis result.

Dimension	*Stress (S)*	*R-Square (R)*
Ecological	0.1569	0.9347
Economical	0.1596	0.9335
Sociocultural	0.1459	0.9429
Technology and Infrastructure	0.1584	0.9316
Legal and Institutional	0.1652	0.9412

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The reference used as the basis for determining the goodness of the results of Goodness-*of-fit* in MDS is that the value is *Stress* less than 0.25 and the *R-square is* more than 0.90. Based on Table 3, the value of the *Stress* fifth dimension used is less than 0.25. Likewise for *R-Square* which shows a value above 0.90. thus, it can be said that MDS analysis meets the criteria a Goodness of fit, so that it is feasible to be discussed / analyzed further.

a. Ecological Dimensions

The results of the MDS analysis for the ecological dimension sustainability status is 50.83. This value is in the range 50-74.99 which means it is quite sustainable. In other words, the ecological conditions in the research area are sufficient to support the agribusiness sustainability system of integration of beef cattle and food crops. The leverage of each attribute in the ecological dimension is illustrated in Tabel.4.

Table 4. Ecological Dimension Attribute's Leverage

No.	Attributes of Ecological Dimension	Leverage
1	Utilization of animal breeding waste for organic fertilizer	1.14
2	Utilization of agricultural waste for animal feed.	1.26
3	Beef cattle maintenance system	0.72
4	Land (soil fertility).	1.26
5	Level of land utilization for agriculture and animal breeding	0.91
6	Agro climate	1.79
7	Feed support capacity	2.15
8	Availability of Waste Water Processing Installation	1.92
9	Shed cleanliness	1.94
10	Availability of Animal Slaughterhouse.	1.92
11	Availability of slaughterhouse-waste management installation	2.05
12	The type of animal feed	1.91
13	Availability of land for animal feed (grass and corn leaves)	1.93
14	The quantity of animal breeding waste	1.20
15	The distance of breeding location to community settlement	1.32
16	Drought incidence	1.64
17	The frequency of flood incidence	1.32
18	Rainfall.	0.88
19	The condition of agricultural road infrastructure	0.89
20	The condition of village road infrastructure	1.20

Based on Tabel 4. the ecological dimension attributes that greatly influence dimensional sustainability are the availability of RPH waste treatment, the availability of RPH and the carrying capacity of feed. This is indicated by the leverage value of the three attributes which is greater than the other attributes. Of the three attributes, it can be said that to improve the sustainability of the ecological dimension, the availability of slaughterhouses that are closer and better managed is needed, as well as the ease of obtaining feed.

b. Economic Dimensions

Based on the analysis result of MDS, the economic dimension index of sustainability is 63.33, where this value is in the range of 50-74.99, or in other words quite sustainable. This means that the existence of agribusiness in the system of integration of beef cattle and food crops in the research area is quite beneficial from an economic point of view. The leverage of each economical is shown in Table 5.

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Tabel 5. Economical Dimension Attribute's Leverage

No.	Attributes of Economical Dimension	Leverage
1	Average breeders' income relative to the minimum wage in Jember District.	1.40
2	Average breeders' income relative to total revenue.	1.52
3	The market for animal breeding agroindustry products.	1.91
4	Availability of animal market/agribusiness sub terminal.	2.49
5	The place where breeders sell their animals	2.46
6	Availability of animal feed industry	3.05
7	Changes in Regional Income value in husbandry (in the last 5 years)	2.37
8	Financial feasibility of beef cattle breeding business	2.35
9	Amount of subsidy	2.26
10	Percentage of poor population	1.57
11	Price of an animal commodity	1.48
12	Amount of agricultural workers	1.77
13	Type of key commodities	1.21
14	Agro-industry business feasibility	1.21
15	Level of consumer dependency	1.35

Although livestock / farm business is quite profitable from an economic standpoint, so that its existence can be maintained or even increased, several attributes need to be considered because it has a large influence on the economic dimension.

Based on Tabel 5, the attributes that greatly affect the sustainability of the economic dimension are the availability of the feed industry, the availability of livestock / sub terminal agribusiness markets and the place where farmers sell their livestock.

c. Socio-Cultural Dimensions

The results of the MDS analysis of the socio-cultural dimensions of sustainability is 61.63. The index is in the range of 50-74.99, which means it is quite sustainable. In other words, social and cultural / cultural conditions in the research area are sufficient to support the existence of agribusiness systems for the integration of beef cattle and plants because businesses have generally been carried out for generations, and most of the land that is owned by farmers / farmers is inherited land.

Table 6. Sociocultural Dimension Attribute's Leverage

No.	**Attributes of Sociocultural Dimension**	**Leverage**
1	Work is done individually or collectively	2.52
2	Amount of animal breeder households	2.02
3	Annual growth of animal breeder households (2006-2011)	2.67
4	Environmental knowledge	2.94
5	Level of workforce absorption in animal breeding agroindustry	3.76
6	The frequency of conflicts related to animal breeding	3.91
7	Family participation in animal breeding agribusiness	3.28
8	Community role in animal breeding business	4.30
9	The frequency of counseling and training	3.12
10	Level of agricultural workforce absorption	3.01
11	Business alternative besides animal breeding	2.67
12	Amount of people working in animal breeding agroindustry	2.36
13	Time allocated for animal breeding agribusiness	2.11
14	Amount of village with people working in the animal breeding sector	2.33

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From Tabel 6. it can be seen that this attribute that greatly influences the sustainability of the socio-cultural dimension is the role of the community in livestock business, the frequency of conflict and the level of employment. The results of the analysis show that although livestock / farm business is sufficiently supported in the research area, the effort is not sufficient to absorb labor, so that if this condition is allowed to continue, then the long-term sustainability of livestock / farm business can be threatened.

d. Technology and Infrastructure Dimensions

The output of the MDS analysis for the sustainability status of the technology and infrastructure dimensions is is 18.84. This index is in the range of 0.00 -19.99 which means it is not sustainable. This happens because there are generally farmers / farmers still using traditional methods in carrying out their business. However, the results of this analysis indicate that if the conditions of technology and infrastructure dimensions are not fixed or continue to use traditional methods, then the agribusiness system for integration of beef cattle and plants cannot develop properly because of losing competition caused by a lack of availability of technology and infrastructure.

Table 7. Technology and Infrastructure Dimension Attribute's Leverage

No.	Attributes of Technology and infrastructure Dimension	Leverage
1	Distribution of animal health facility or (*Poskeswan)*	1.96
2	Distribution of artificial insemination service facility	5.53
3	The use of vitamin and probiotic to boost animal growth	2.05
4	Animal feed technology	2.46
5	Animal breeding/agroindustry waste processing technology	2.28
6	Animal breeding product processing technology	2.65
7	Information and transportation technology	2.57
8	Availability of agribusiness facilities and infrastructures	2.80
9	Availability of public facilities and infrastructures	2.52
10	Level of animal breeding technology mastery	1,91
11	Availability of animal breeding information technology	2.18
12	Quality standardization for animal products	2.02

From Table 7, attributes that greatly influence the sustainability of the dimensions of technology and infrastructure are the distribution of artificial insemination service posts, the availability of agribusiness facilities and infrastructure as well as the technology for processing livestock products. In other words, improvements in terms of sustainability in the dimensions of technology and infrastructure can be focused by making a service post for artificial insemination, as well as providing facilities and infrastructure that support livestock business activities such as livestock extension centers and so on. In addition, the provision of technology in processing livestock products is also seen as being able to improve the agribusiness conditions for the integration of existing dairy cows and plants.

e. Law and Institutional Dimensions

The results of the MDS analysis for the legal and institutional dimensions of sustainability is 17.38. This index is in the range of 0.00-19.99, which means it is not sustainable. This shows that the support of the government and local institutions for agribusiness systems integration of beef cattle and food crop are still minimal.

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Table 8. Legal and Institutional Dimension Attribute's Leverage

No.	Attributes of Legal and institutional Dimension	Leverage
1	Consultation and training center owned by farmers	4.19
2	Cooperation agreement with other regions in animal breeding	3.78
3	Policy synchronization between the central and regional government	3.59
4	Farming groups	4.19
5	Availability of social institutions	4.08
6	Microfinance institutions (bank/credit)	3.55
7	Agricultural extension office or (*BPP*)	2.85
8	Regional governing body	3.81

Based on Table 8, of the eight attributes used to measure legal and institutional dimensions, in general has almost the same or balanced leverage. That is, the eight attributes deserve the same attention in order to improve the sustainability of the legal and institutional dimensions. However, the attributes that have the highest leverage are livestock farmer groups, training centers and consultation and availability of social institutions.

Furthermore, the relationship combination of the five dimensions used to measure the sustainability of agribusiness systems integration of beef cattle business and food crop farming in the research area is shown in Figure 1.

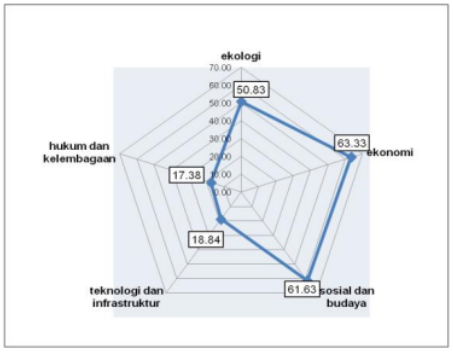

Figure 1. Sustainability status diagram

On average, the index value of the sustainability of agribusiness enterprises in the integration system of dairy cows and food crops in the study area is 42.40 or at intervals of 25.00 - 49.99 (less sustainable). From the kite diagram, if the index comes out or approaches the number 100, then it shows that the sustainability status is getting better, conversely if it gets deeper or closer to the value of 0, then it shows that sustainability status is getting worse. Of the five dimensions, the dimensions that have the worst sustainability index value are the dimensions of technology and infrastructure and the legal and institutional dimensions of 18.84 and 17.38 respectively (unsustainable).

The results of the study are in accordance with [7] livestock farming business activities are part of the livestock agribusiness system that includes four subsystems, namely: subsystem upstream *off-farm agri-business*; livestock farming agribusiness subsystem (*on-farm agribusiness*); subsystem downstream *off-farm agribusiness*; and subsystems of supporting *institutions*.

Added [8], livestock agribusiness is defined as an activity in the field of livestock business that handles all aspects of the production cycle in a balanced manner in a complete policy package through the management of procurement, supply and distribution of production facilities, cultivation

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activities, marketing management by involving all stakeholders (stakeholders) with the aim of obtaining balanced and proportional benefits for both parties (farmers and private companies).

The livestock integration system with plants is one of activities organic *farming technology*-based, by utilizing locally recycled resources effectively. This system involves at least three types of interrelated farming activities, namely: (1) cultivation of beef cattle, (2) cultivation of food crops or plantations, and (3) processing of agricultural and livestock waste.

The scope of livestock cultivation includes animal husbandry, feeding systems, processing of livestock and waste products, and utilization of compost for agricultural crops. Plant cultivation is a technology of product processing, storage and improvement in the quality of plant waste as animal feed. Composting is the process of converting organic waste into fertilizer with the aim of reducing organic material contained in waste materials, suppressing the onset of odor, killing weeds and pathogenic organisms, the product in the form of organic fertilizers suitable for application to agricultural land [9]

4. Conclusion

Based on the five dimensions of sustainability that exist, the agribusiness business system of integration of beef cattle and plants in the study area has a sustainability index value of 42.40. The index shows that agribusiness is still less sustainable. The dimensions that have the worst sustainability index and need serious attention are the dimensions of technology and infrastructure, as well as the legal and institutional dimensions.

Recommendations

Attention is needed to the improvement of the provision of technology, infrastructure, law and institutions in the research area, so that the integration of beef cattle and food crop business can become a sustainable dimension.

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