Sustainability status of integrated rice-corn and beef cattle farming agriculture business in Jember regency

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Abstract. The research was aimed to analyze the sustainability status of a particular form of integrated agriculture business system namely rice-corn pattern planting with beef cattle breeding. The selection of research location was done based on the Multistage Sampling Method, and Purpose Sampling Method. Jember Regency was selected as the research location, because information obtained from the preliminary survey shows that paddy fields with technical irrigation system were common in Jember Regency and thus several planting patterns can be used in a particular year, namely: Rice – Corn planting pattern. In addition, farmers are also used to breed cattle especially beef cattle as an additional activity to their main farming business. Data analysis was conducted using Sustainability Analysis with MDS Rap-SISPOTTA. Based on five sustainability dimensions used here namely ecological, economic, technology and infrastructure, sociocultural, as well as legal and institutional; results were obtained indicating that an integrated beef cattle and crops agriculture business system in the studied region has a sustainability index of 44.0. It indicates that the integrated agriculture business implemented is still less sustainable dimensions with the lowest index of sustainability and thus must seriously be given attention are technology and infrastructure, as well as legal and institution.

1. Introduction
Integration between food crops farming and beef cattle breeding is basically a mix of two commodities that can be developed simultaneously in a particular area, where the existence of a commodity is necessary for the other, and vice versa. Food crops will produce agricultural waste which can be utilized as animal feed. Meanwhile, beef cattle can produce potential manure to be utilized to fertilize the crops and improve soil physical condition. Through the fulfillment of any input facility especially animal feed for the beef cattle and organic fertilizer for the food crops, it is expected that the production cost will be reduced and production will increase. Ultimately, it will increase farmers' income and welfare as well as support food and meat self-sufficiency in Indonesia [1].

The implementation of a sustainable agriculture system can be used as a momentum to encourage the development of people economy. Basically, farmers are more than ready to accept a sustainable agriculture system because the necessary input is widely available in the surrounding environment. Even before being introduced to the agriculture intensification using fertilizer and chemical pesticide,

farmers have been implementing environmentally-friendly sustainable agriculture system, for instance by using manure. Equipped with their traditional knowledge, farmers must be empowered to further increase their knowledge on sustainable agriculture, as well as to identify opportunities and market demands for high quality and environmentally-friendly products. Therefore, farmers can produce agriculture products with high economic value while also continue to preserve environmental function [2].

According to [3] sustainable agriculture is the management of agricultural resources to meet the changing needs of a human while continue to maintain or increase the quality of the environment and preserve natural resources. Also, purposes of managing a farming business for farmer households are productivity, security, continuity, and identity. The same was said by [4], there should be rearrangement in the form of integration towards ecosystem-oriented dual utilization. Although agro-ecosystem is a complex and complicated management, its most important specific characteristics are related to four principles. The four principles are equitability, sustainability, stability, and productivity.

2. Research Method

The research was conducted in Jember District in a purposive manner by considering that the region is one of the regions with quite wide technical irrigation fields and has the potential for beef cattle breeding development. The sample used in this research are farmers/breeders who implement plant cultivation system in 1 (one) year with Rice-Corn planting pattern model, and breed beef cattle for more than 1 (one) year, as well as have the experience in breeding beef cattle for more than three years.

The analysis method for sustainability status used the *Rap-SISPOTTA modified* method, namely a new multi-disciplinary rapid appraisal method to evaluate sustainability [5]; [6]. The assessment of sustainability was based on 3-5 dimensions or sustainable metrics aspects, namely economic, ecological, environmental, technical, institutional, and sociological.

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 for each dimension was analyzed using Multi-Dimensional Scaling (MDS). All values of each dimension's attributes were entered into Microsoft Excel program and then analyzed with MDS using Excel for Rap-SISPOTTA, a set of analysis can be simultaneously conducted including feasibility and significance analysis, sustainability status analysis, and sustainability model simulation analysis.

2.1. Feasibility and Significance Test for Sustainability Model.

Feasibility test of a sustainability model was done through the calculation of *goodness of fit* from the distance between an estimated point and original point through *S-stress* calculation. The *least square* technique was used to determine the goodness of fit based on the square root of *Euclidian distance (squared distance)* or the *algorithm of scale (ALSCAL)* method. ALSCAL method optimizes the squared distance on the original point squared data (W_{ijk}), thus *S-Stress* value was calculated using the following formula:

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

The goodness of fit in MDS is the measure of how well one point may reflect the original data, which is determined by the *S-Stress* value resulted from the S value calculation. The goodness of fit in MDS analysis is determined by the S-Stress value resulted from a calculation where the low-stress value indicates a good-of-fit, while high S value indicates the opposite. In RAP-SISPOTTA modified, a good model is reflected by a *stress* value lower than 0.25, while a *stress* value higher than 0.25 means low good-of-fit. Rap-SISPOTTA modified also calculates uncertainty aspect using Monte Carlo analysis technique. Uncertainty is caused by the impact of error in scoring due to the lack of information, the impact of variation in scoring due to the difference in assessment, error in data entry, and high-*stress* level obtained from the ALSCAL algorithm. *Monte Carlo* analysis is also a simulation model to evaluate the impact of random error in the analysis conducted to the whole attributes of each dimension. In this case, *Monte Carlo* is not conducted using the scatter pilot method that shows the ordination of each dimension.

On [5] explained that with Rap-SISPOTTA modified, an object is observed based on two to five dimensions, thus the ordination technique in MDS is based on *n Euclidian Distance* in a particular dimension. For this research, five dimensions were used using the following formula:

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

Significance test in the sustainability model was done based on the configuration or ordination of an object or point in MDS which is approximated by regressing the Euclidian distance (d), from the point I to point j with the original point (δ_y) in the following equation:

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

The squared distance is the weighted Euclidian distance or can be written as:

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

The determinant of significance can be seen from the processed RAP-SISPOTTA with the highest Root Means Square (RMS) value until the half value of each sustainability dimension, where [6] stated that the lever factor of significance is the attributes that sensitively influence the increase or decrease of sustainability status. Higher RMS value means greater significance or the greater role of an attribute towards the sensitivity of sustainability status.

2.2. Sustainability status assessment.

Assessment of the whole attributes of each sustainability dimension in integrated beef cattle and horticulture crops agribusiness system was categorized into good, pretty good, not good, and bad status. The assumption for performance was placed between 0 to 100% or bad to good. Between bad and good, performance interval was placed; enough or lacking, resulting to four performance levels i.e. bad, lacking, enough, and good, thus creating 25%, 50%, 75%, and 100% intervals.

Assessment result for the performance of each dimension's attributes was mapped in two reference points which is bad and good, while performance level was distinguished into 4 (four) categories, as stated by [5]. These categories are presented in the following 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 of MDS-Rap-SISPOTTA analysis result for the 5 (five) dimensions is presented in the following Table 3. The reference used as the basis to determine the analysis result's goodness of fit in MDS is *Stress* value less than 0.25 and an *R-square* value greater than 0.90. According to Table 3, it is shown that the *Stress* value of the five dimensions is less than 0.25. Similarly, the *R-square* value is also greater than 0.90. In conclusion, MDS analysis has met the Goodness-of-fit criteria and thus can be further discussed and analyzed

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

3.1. Ecological Dimension

Based on the analysis result of MDS, sustainability status index for the ecological dimension is 58.53, which is in the 50-74.99 range indicating quite sustainable. In other words, the ecological condition of the studied region is quite supportive of integrated agribusiness system especially for Rice-Corn and beef cattle farming. 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	1.59
2	Utilization of agricultural waste for animal feed.	1.85
3	Beef cattle maintenance system	1.57
4	Land (soil fertility).	0.88
5	Level of land utilization for agriculture and animal breeding	6.00
6	Agro climate	4.34
7	Feed support capacity	12.43
8	Availability of Waste Water Processing Installation	16.2
9	Shed cleanliness	30.18
10	Availability of Animal Slaughterhouse.	28.87
11	Availability of slaughterhouse-waste management installation	29.48
12	The type of animal feed	5.40
13	Availability of land for animal feed (grass and corn leaves)	7.80
14	The quantity of animal breeding waste	7.94
15	The distance of breeding location to community settlement	6.01
16	Drought incidence	9.44
17	The frequency of flood incidence	5.95
18	Rainfall.	3.53
19	The condition of agricultural road infrastructure	16.68
20	The condition of village road infrastructure	2.35

Based on Tabel 4, attributes for the ecological dimension that highly influence the sustainability of this dimension are shed cleanliness, availability of slaughterhouse waste management facility, and availability of animal slaughterhouse. These are indicated by the leverage values of the three attributes that are higher than those of other attributes. Out of the three attributes, it can be said that to improve sustainability in ecological dimension there is a need for animal slaughterhouse that is closer in distance and managed well especially in terms of waste management and shed cleanliness.

3.2. Economical Dimension

Based on the analysis result of MDS, that sustainability status index of economic dimension is 52.44, which is inside the 50-74.99 range or indicates quite sustainable. This means that the existence of integrated rice-corn and beef cattle farming agribusiness in the studied region is quite beneficial from the economic perspective. The leverage of each economical is shown in Table 5. attributes with the highest influence towards the sustainability status of an economic dimension in integrated rice-corn and beef cattle farming agribusiness is the financial feasibility of beef cattle breeding, production market for animal breeding agroindustry, and changes in Regional Income of husbandry sector for the last five years.

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.	2.77
2	Average breeders' income relative to total revenue.	3.55
3	The market for animal breeding agroindustry products.	4.88
4	Availability of animal market/agribusiness sub terminal.	2.18
5	The place where breeders sell their animals	2.55
6	Availability of animal feed industry	4.41
7	Changes in Regional Income value in husbandry (in the last 5 years)	4.84
8	Financial feasibility of beef cattle breeding business	5.07
9	Amount of subsidy	4.80
10	Percentage of poor population	2.42
11	Price of an animal commodity	4.09
12	Amount of agricultural workers	2.42
13	Type of key commodities	1.04

3.3. Sociocultural Dimension

MDS analysis result for sustainability status index of sociocultural dimension is 69.07. This index value is inside the 50-74.99 range, or in other words, indicates quite sustainable. This also means that the sociocultural condition of the studied region is quite supportive of integrated agribusiness system especially for Rice-Corn and beef cattle farming.

While the leverage of each sociocultural dimension's attribute is shown in Table 6. According to Table 6, attributes with the highest influence towards sustainability of the sociocultural dimension are time allocated for animal breeding agribusiness, the frequency of conflicts related to animal breeding, and the number of breeder households. The result of the analysis shows that time allocated and the number of households working in the animal breeding industry, as well as the number of conflicts – if not managed well and received serious attention – may prove to be a threat in the sustainability of integrated rice-corn and beef cattle farming agribusiness

Table 6. Sociocultural Dimension Attribute's Leverage

No.	Attributes of Sociocultural Dimension	Leverage
1	Work is done individually or collectively	48.23
2	Amount of animal breeder households	52.01
3	Annual growth of animal breeder households (2006-2011)	15.78
4	Environmental knowledge	51.05
5	Level of workforce absorption in animal breeding agroindustry	45.28
6	The frequency of conflicts related to animal breeding	52.31
7	Family participation in animal breeding agribusiness	49.97
8	Community role in animal breeding business	36.53
9	The frequency of counseling and training	5.557
10	Level of agricultural workforce absorption	3.16
11	Business alternative besides animal breeding	12.25
12	Amount of people working in animal breeding agroindustry	14.14
13	Time allocated for animal breeding agribusiness	53.40
14	Amount of village with people working in the animal breeding sector	13.60

3.4. Technology and Infrastructure Dimension
The leverage of each technology and infrastructure dimension's attribute has shown in Table 7.

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*)	2.86
2	Distribution of artificial insemination service facility	3.65
3	The use of vitamin and probiotic to boost animal growth	4.52
4	Animal feed technology	5.11
5	Animal breeding/agroindustry waste processing technology	3.63
6	Animal breeding product processing technology	3.66
7	Information and transportation technology	3.53
8	Availability of agribusiness facilities and infrastructures	4.01
9	Availability of public facilities and infrastructures	3.19
10	Level of animal breeding technology mastery	3.27
11	Availability of animal breeding information technology	2.19
12	Quality standardization for animal products	1.99

The output of MDS analysis for the sustainability status index of technology and infrastructure dimension is 18.41. This index value is in the 0.00-19.99 range which means not sustainable. The value was obtained because farmers or breeders mostly still use traditional methods in managing their business. Based on Table 7 below, attributes with the highest influence on the sustainability of technology and infrastructure dimension are animal feed industry and animal growth booster. This means that from a technology and infrastructure standpoint, these aspects do not support business sustainability due to the lack of innovation in feed technology and animal growth booster
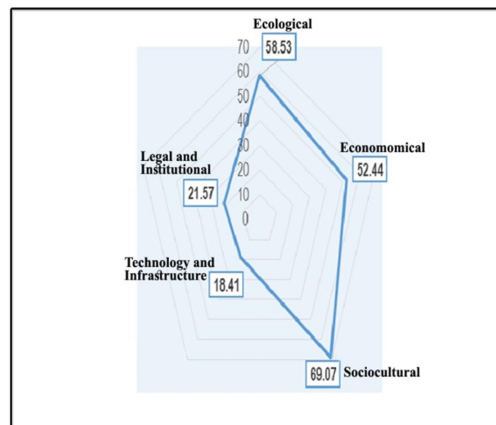
3.5. Legal and Institutional Dimension
The result of MDS analysis for sustainability status index of legal and institutional dimension is 21.57. This index value is in the 20-24.99 range which means less sustainable. Meanwhile, attributes that highly influence the sustainability of this dimension is presented in Table 8. According to Table 8, out of eight attributes used to assess legal and institutional dimension, those with the greatest leverage or ones with the highest influence towards the sustainability of legal and institutional dimension are the availability of social institutions and policy synchronization between central and regional government.

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	4.55
2	Cooperation agreement with other regions in animal breeding	5.16
3	Policy synchronization between the central and regional government	7.03
4	Farming groups	6.66
5	Availability of social institutions	7.46
6	Microfinance institutions (bank/credit)	5.68
7	Agricultural extension office or (*BPP)*	2.87
8	Regional governing body	5.45

Figure 1 shows that a combination of five dimensions was used to measure the sustainability of integrated rice-corn and beef cattle farming agribusiness. In average, index value for the sustainability of integrated rice-corn and beef cattle farming agribusiness in Jember District is 44.00 or in the 25.00 – 49.99 range (less sustainable).

Figure 1. Sustainability Status Diagram

4. Conclusions
4.1. Conclusions
Based on five sustainability dimensions used in this research, the integrated rice-corn and beef cattle farming agribusiness in Jember District shows a sustainability index value of 44.00. This index value means that this particular agribusiness model is still less sustainable. Dimensions with the lowest sustainability index and must receive serious attention are technology and infrastructure dimension, as well as legal and institutional dimension, with each scored 18.41 dan 21.57 respectively.
4.2. Recommendations
In order to improve the sustainability status of aforementioned dimensions, serious attention must be given to improving the adequate provision of technology, infrastructure, legal, and institutional in the studied region so that the integration of rice-corn pattern planting and beef cattle breeding can be a sustainable business.

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