Analysis of Sustainability Status of Integration of Beef Cattle and Paddy with Technology Innovation of Rice Straw as Feed and Beef Cattle Manure as Fertilizer and Biogas

by H M Ali

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Analysis of Sustainability Status of Integration of Beef Cattle and Paddy with Technology Innovation of Rice Straw as Feed and Beef Cattle Manure as Fertilizer and Biogas

Jasmal A. Syamsu[1*], Hikmah M. Ali[2], Muhammad Ridwan[3], and Mawardi A. Asja[4]

[1]*Department of Animal Nutrition and Feed Science, Hasanuddin University, Makassar, Indonesia*

[2]*Department of Animal Production, Hasanuddin University, Makassar, Indonesia*

[3]*Department of Socio-Economics of Animal Husbandry, Hasanuddin University, Makassar, Indonesia*

[4]*Department of Animal Husbandry, Sulawesi Barat University, Majene, Indonesia*

Abstract

The objective of this study was to analyze sustainability indexes and status on the integration between beef cattle and paddy with technological innovation of rice straw as feed, cow manure as fertilizer and biogas. Primary data were obtained through interviews with the farmers with the help of a questionnaire. The farmers were randomly selected as samples, and also involved experts/practitioners as respondents who have related expertise, reputation and/or experience with the present study. In addition focus group discussions were conducted with the farmers, in order to identify the actual problems and conditions that usually occur in development of the integration between beef cattle and paddy. Furthermore, in depth interviews were performed with the key informants. The method to analyze sustainability status was a modification of Rapfish by using Multi-Dimensional Scaling (MDS). This method is named, RAP-Intrasadi (Rapid Appraisal Integration Beef cattle and Paddy). The results of this study showed that the sustainability status has multidimensional index values of sustainability. Integration produced beef cattle and rice with technological innovation, rice straw as feed processing, livestock manure as fertilizer and biogas was implemented by farmers in rural farmers and produced an index value of 46.12 (less sustainable). To improve the sustainability status, it must be repaired to the sensitive attribute in each dimension. Ecological dimension attribute a) potential and carrying capacity of livestock waste, b) potential and carrying capacity of rice straw, and c) management of farm cattle farming. Attributes that need improvement for the economic dimension were contribution of livestock waste biogas to fuel costs, the number and ownership of paddy fields, and the number and ownership of cattle. Atributes of social dimension were level of willingness and motivation to utilize rice straw, understanding the impact of waste on the environment, and the integration of related experience of beef cattle and rice. While technological dimension were biogas processing facilities and infrastructure.

*Corresponding author
E-mail: jasmals@yahoo.com

fertilizer processing facilities and infrastructure, and application of cattle waste treatment technologies as biogas

Key words Sustainability/ Beef cattle/Paddy/ Biogas/ Fertilizer/ Rice straw

1 Introduction

The agricultural sector, which includes the crop and livestock sector is integrated to the point, where they cannot be separated and are complementary Efforts to integrate livestock with paddy cultivation will have a positive impact, both socially and economically Livestock farming becomes more efficient with the availability of food that can be produced continuously (Diwyanto and Haryanto 2001) In addition, the social problems caused by waste in the form of paddy rice straw and animal waste in the form of manure that has been polluting products can be solved efficiently by turning them into fertilizer and feed, as well as a good influence on farmers economics, resulting in operational efficiency

System integration of beef cattle and paddy produce economic benefits and optimize utilization of resources To implement these integration patterns requires at least the knowledge and skills of farmers in the application of biogas technology, fertilizer processing, and processing of rice straw as feed is required (Syamsu, 2007) Moreover, Syamsu et al (2003) reported that agricultural waste has considerable potential as a source of animal feed Total production of agricultural waste in Indonesia was 51,546,297 3 tons with the largest production being rice straw at 44,229,343 0 tons of dry matter or 85 81% of the total production of agricultural waste (food crops) Based on the TDN (*total digestible nutrient*) production of agricultural waste could provide fodder for 14 750 777 1 LU (livestock units), so with the current population of ruminants at only 11,995,340 LU There is still a possibility to increase the ruminant population by 2 755,437 1 LU or 18 68% On the other hand, the Directorate General of Livestock (2007) stated that based on the population of cattle in Indonesia, which consists of large ruminants is 13 68 million head 21 688 million head small ruminants, non-ruminants 7 001 million head and poultry 1,283,164 000 head It can be assumed that much as 80 194 166 tons of fresh manure could be produced,

and if processed, it would produce about 32 million tons of organic fertilizer.

According to these potential figures of rice straw waste and livestock manure, which are quite large as described above, then the integration of beef cattle and paddy could solve the problem and lead to the concept of sustainable agricultural development. The integration of beef cattle and paddy which aims to increase the production of each commodity by the use of external inputs is expensive and environmentally damaging. Therefore, efforts in resource utilization of waste rice straw and manure in order to have value added through processing and technological innovation can contribute to improved farm productivity (Syamsu, 2011). Thus the integration of cattle and paddy is expected to be one of the ways in maintaining sustainable farming (agriculture sustainable) by simultaneously considering, the environment, social acceptance, and is it also economically feasible.

The objective of this study was to analyze the sustainability status of the integration between beef cattle and paddy with technological innovation as rice straw feed, cow manureas fertilizer and biogas. By understanding the status of sustainability based on the dimensions of ecology, economics, social and cultural, and technology will help to improve the sensitive attributes that affect the increased integration of sustainability status of beef cattle and paddy.

2. Methodology

The study was conducted in Pinrang, South Sulawesi Province, Indonesia, during a period from March to September 2012. Primary data was obtained through interviews using a questionnaire instrument, namely a structured questionnaire addressed to the selected respondent as samples. Selection of the farmers as respondents was randomly conducted with the samples. Number of respondents at each of the selected sites was calculated by Slovin (Umar, 1997). In this study some experts were involved as respondents. Elective experts were prioritized the expert/practitioner who has the expertise, reputation and/or experience in aspects related to the study. In addition it also conducted focus group discussions. the focus group discussions were done to farmersto identify actual problems and conditions that occur in the development of beef cattle and paddy. Besides, it also conducted in-depth interviews with some key informants.

Method to analyze the sustainability status of integration between beef cattle and paddy was a modification of Rapfish (Rapid Assessment Techniques for Fisheries) developed by the Fisheries Center, University of British Columbia using Multi-Dimensional Scaling (MDS) (Kavanagh, 2001, Fauzi and Anna, 2002). This method named RAP-Intrasadi (Rapid Appraisal Integration Beef cattle and Paddy). MDS is a method of computer-based statistical analysis techniques using SPSS software, the transformation of every dimension and sustainable development of the integration of multidimensional beef cattle and paddy. Analyses of data with MDS include the integration of sustainability aspects of beef cattle and paddy from different dimensions of ecology, economics, technology and social culture. Analysis of the status and sustainability index performed several stages as shown in Figure 1.

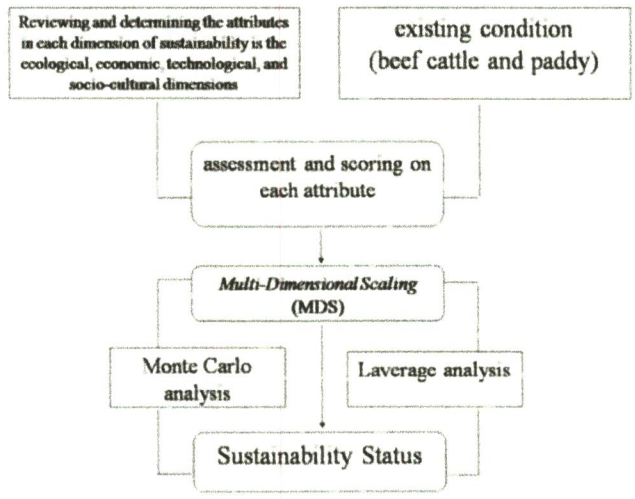

Figure 1 Stage of Sustainability Status Analysis of integration of beef cattle and paddy

Stage of the sustainability status analysis of integration beef cattle and paddy were a) reviewing and determining the attributes in each dimension of sustainability. These were the ecological, economic, technological, and socio-cultural dimensions. Determination of attributes and definitions related to the results of the previous phase of research (existing condition). b) assessment and scoring on each attribute of each dimension ordinal scale each dimension

of sustainability criteria, which were based on the existing condition of research and expert opinion. Range of scores ranging from 0-3 was interpreted from bad to good or vice versa, according to the condition of each attribute. c) based on the scoring of each attribute, and then analyzed using the MDS, to determine the position of the integration of sustainability status of beef cattle and paddy on each dimension of sustainability and multi dimensional indices represented by the status of sustainability. Status and sustainability indexcategory can be seen on Table1.

Table 1. Sustainability Status Category of Integration Beef Cattle and Paddy

Category	Sustainability Status
0.00 – 25.00	Poor (Not Sustainable)
25.01 – 50.00	Less (Less Sustainable)
50.01 – 75.00	Fair (Quite Sustainable
75.01 – 100.00	Good (Very Sustainable)

Through MDS, the position of the point of sustainability can be visualized in two dimensions (horizontal and vertical axis). To project the points on the horizontal line made the rotation, with the extremes of "poor" rated score of 0% and the extremes of "good" was given a score value of 100%. Position sustainability of the system under study will be among the two extremes. This value was an index value of sustainability integration of beef cattle and paddy.

With the analysis of the sustainability status, Laverage analysis, Monte Carlo analysis, determination of the stress, and the value of coefficient of determination (R2), which was a package of all these analyzes of the MDS program.

a) Laverage analysis is the analysis conducted to determine the attributes of each dimension are sensitive to integration enhances the sustainability status of beef cattle and paddy. Sensitive attributes specified by priority of the analysis by looking at the root mean square (RMS) on the X-axis ordination. The larger the RMS value changes an attribute, then that attribute has a greater role in improving the sustainability status of integration of beef cattle and paddy.

b) Monte Carlo analysis is used to estimate the effect of the error analysis, the level or the 95% confidence interval whose value is expressed in terms of index value

Monte Carlo, which further distinguished by the value of the index MDS analysis.

c) Stress values and coefficient of determination (R2), was used to determine if whether or not the addition of attributes, to reflect accurately assess dimensions.

3. Results and Discussion

The results of the RAP Intrasadi analysis (Rapid Appraisal Integration Beef Cattle and Paddy) in multi-dimensional revealed that the integration of beef cattle and paddy with technological innovation rice straw as feed, livestock manure as fertilizer and biogas were implemented by farmers in rural areas was less sustainable with the sustainability index of 46.12. This value was calculated based on an assessment of the 34 attributes that were included into the four dimensions of ecological dimensions (10 attributes), the economy (7 attributes), social-culture (8 attributes), and technology (9 attributes), as shown in Table 2. Similar findings have been shown in the study of Suyitman et al. (2009) that the ecological dimension was less sustainable (46.50%) than the other factors. These factors affect, directly and indirectly, the social and economic sustainability of the farmers (Alam et al., 2010). Sustainability index value for each dimension, the value of stress, and R2 are shown in Table 3.

Table 2. Dimensions and Attributes of Sustainability Integration Status of Beef Cattle and Paddy

No	Dimension		Atribute
1	Ecological	1.	Density areas and livestock level
		2.	Potential and carrying capacity of manure
		3.	Potential and carrying capacity of rice straw
		4.	Usage of manure as biogas
		5.	Usage of manure as fertilizer
		6.	Usage of rice straw as feed
		7.	Management of beef cattle farming
		8.	Management of rice farming
		9.	Cow manure pollution levels
		10.	Rice straw pollution levels

Table 2 (Continue)

No	Dimension		Atribute
2	Economy	1	The number and status of cattle ownership
		2	The amount and tenure fields
		3	Contribution of livestock waste / biogas to fuel costs
		4	Contribution of livestock waste to fertilizer costs
		5	Contribution of rice straw as feed to beef cattle feed cost
		6	Benefits and economic value of manure
		7	Benefits and economic value of rice straw
3	Social-culture	1	Guidance and counseling in sewage treatment
		2	Farmers experience related to the integration of beef cattle and paddy
		3	Understanding the impact of waste on the environment
		4	Level of willingness and motivation to use manure
		5	Level of willingness and motivation to use rice straw
		6	Perceptions of farmers to waste cattle management
		7	Perceptions of farmers to rice straw processing
		8	Farmer s culturee in integration of beef cattle and paddy
4	Technology	1	Feasibility of applying the technology of biogas
		2	Feasibility of applying fertilizer processing technology
		3	Feasibility of application of rice straw processing technology
		4	Biogas processing technology infrastructure
		5	Manure treatment technology infrastructure
		6	Rice straw processing technology infrastructure
		7	Application of cattle waste treatment technologies as biogas
		8	Application of cattle waste treatment technologies as fertilizer
		9	Application processing technology of rice straw as a feed

Table 3 Result of MDS, Monte Carlo and Statisticsanalysis

Dimensions	Sustainability Index		Difference	Statistics		Iterasi
	MDS	Monte Carlo		Stress	R	
Ecological	45.545	46.110	0.565	0.147	0.949	2
Economy	40.243	40.293	0.050	0.157	0.941	2
Social-culture	45.200	46.011	0.811	0.140	0.945	2
Technology	53.493	53.159	0.334	0.133	0.950	2

Table 3 shows that the value of stress tests of each dimension is quite low in the range of 0.13 to 0.14 and the coefficient of determination R2 approximately 0.94 to 0.95. This suggests that the quality of the analysis was quite

good. Both of these parameters indicate that all the attributes used were quite good in explaining the sustainability index and the status of the integration of beef cattle and paddy. In comparison between this study and the study of Kikuhara and Hirooka (2009) on application of a simulation model for dairy cattle production systems integrated with forage crop production in Japan concluded that they observed in most cases that dairy and forage rice integration systems could not be economically established without subsidies. This indicated that there is a difference between integration of beef cattle and paddy and integration of dairy cattle and paddy. Raising systems for beef cattle were conducted extensively especially in the present study, while dairy cattle were mainly used in fully housing system such as the study of Kikuhara and Hirooka (2009).

The difference in the results of MDS and Monte Carlo as shown in Table 3 are quite small which indicates that the error in the manufacture of each attribute score was relatively small, variations due to differences in the subjective scoring was relatively small, the analysis process performed repeatedly stable and data entry errors and missing data can be avoided. Overall, these results indicate that RAP-Intrasadi analysis using MDS to determine the sustainability of the integration of beef cattle and paddy had a high level of confidence. Thus RAP-Intrasadi method can be used as a tool to assess the rapid evaluation (rapid appraisal sustainability integration of beef cattle and paddy in areas/regions that have the same characteristics with the location of this study. Multidimensional index of sustainability can also be seen in Figure 2.

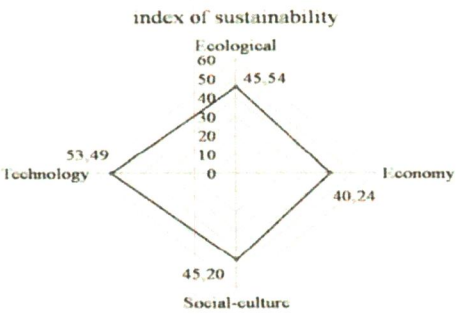

Figure 2 Kite diagram of four RAP-Intrasadi evaluation fields showing status score ofthe integration beef cattl eand paddy

The results of the analysis showed that RAP-Intrasadi sustainability index for ecological dimensions were 45.54 and sensitive attributes on the system integration of beef cattle and rice (Figure 3). This value indicates that the integration of beef cattle paddy based on dimension ecologically was less sustainable. Sensitive attributes as leverage factor in determining the sustainability of the integration of beef cattle and paddy in ecological dimension were a) the potential and carrying capacity of livestock waste, b) the potential and carrying capacity of rice straw, and c) management of beef cattle farming.

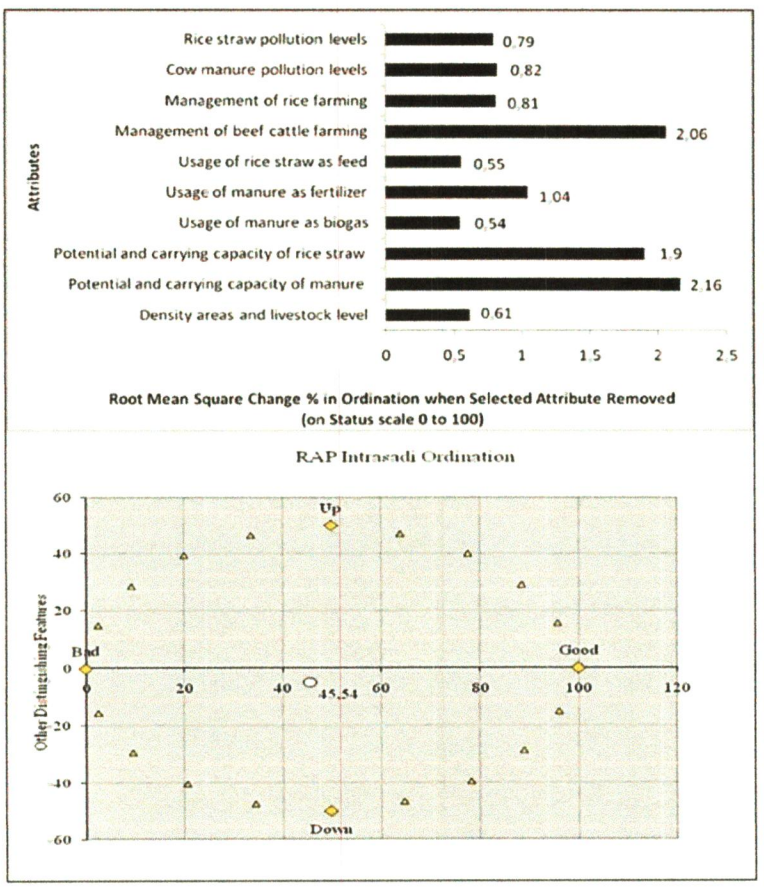

Figure 3. Leverage of ecological attributes on sustainability score and index of sustainability

Based on the ecological dimension that can be formulated to improve the sustainability of the integration of beef cattle and paddy was determined the potential and capacity of beef cattle manure that is able to be converted into biogas and fertilizer. It was crucial to the successful integration of beef cattle and paddy. Kusa et al. (2006) stated that the application of manure from cattle to the paddy fields would be desirable to maintain paddy fields and minimize environmental problems. Besides the potential carrying capacity of rice straw that can be used as feed. It is necessary to increase the utilization of rice straw as a source of cattle feed. This must be done because the conditions of pasture each year undergo conversion to residential land estates, and other types. Sustainability of the beef cattle in the present study whereas ecological base pasture land as a source of feed, will experience a shift by making the substitution utilization of waste as feed crops through the application of the integration of beef cattle and paddy.

The Economic dimensions of sustainability index indicates that less sustainable status with an index of 40.24 and sensitive attributes that affect the status of sustainability can be seen in Figure 4. Sensitive attributes that lever the factors in determining the sustainability of beef cattle and grain integration based on the economic dimension area) contribution of livestock waste as biogas to fuel costs. b) the number and ownership of paddy fields, and c) number and ownership of cattle. Thus, the necessary technology needs to be developed to convert beef cattle waste into biogas to provide economic benefits in reducing house hold expenditure in the form of fuel oil costs for cooking.

In addition, the amount of land and cattle fields determines the sustainability of the integration of beef cattle and paddy in the countryside. Based on the point of view of the economic dimension for sustainabilityof integration of beef cattle and paddy specified tenure and cattle. With a high level of livestock ownership (>10 beef cattle), the farmer can make livestock as a source of income, apart from paddy, and can get input for paddy production in the form of fertilizer by processing animal waste. Levels of input costs for rice production in the form of fertilizer were able to be kept low, because the resources are already owned by the breeders of livestock producing waste. Increased forage rice yield greatly increased animal density, environmental impacts, revenue, production costs and net return (Kikuhara and Hirooka, 2009).

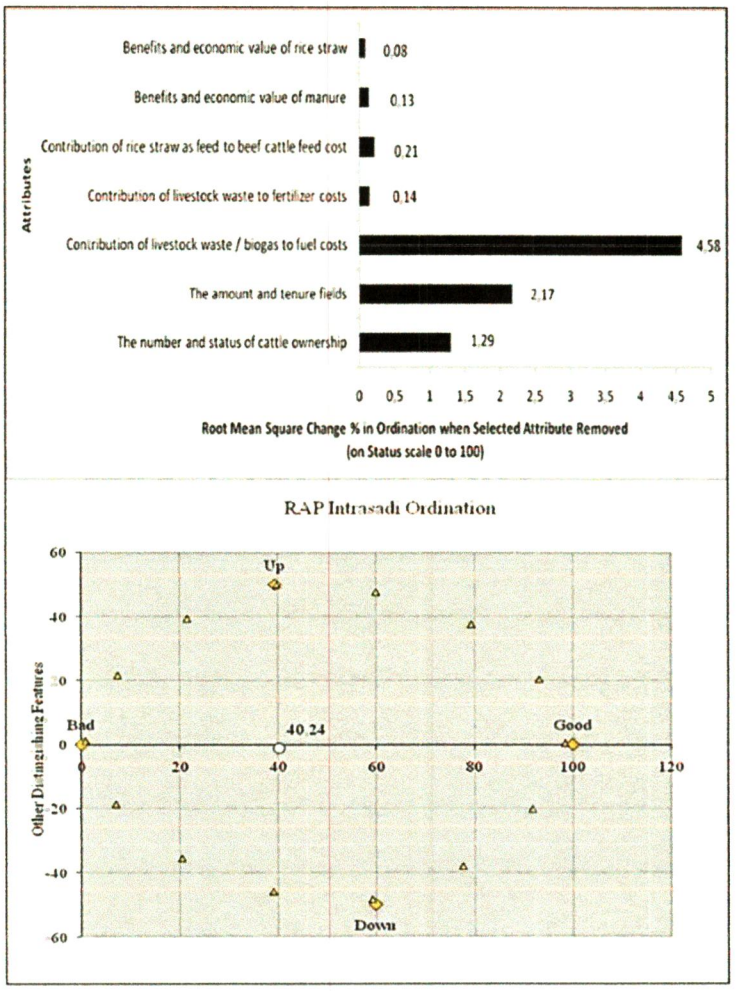

Figure 4 Leverage of economy attributes on sustainability score and index of sustainability

The results of RAP Intrasadi analysis on the social dimension showed that the sustainability index was 45.20. This result shows that based on the social dimension, the integration of beef cattle and paddy were also less sustainable. Figure 5 shows that the relative attributes in determining the sustainability of the integration of beef cattle and paddy in the social dimension are a) level of willingness and motivation to utilize rice straw, b) understanding the impact of waste on the environment, and c) experience related to the integration of beef cattle and paddy. Increasing the knowledge of farmers on rice straw as

processed feed can be improved by increasing motivation and willingness of breeders. Motivation and willingness were the main determinants in the processing and utilization of rice straw as feed.

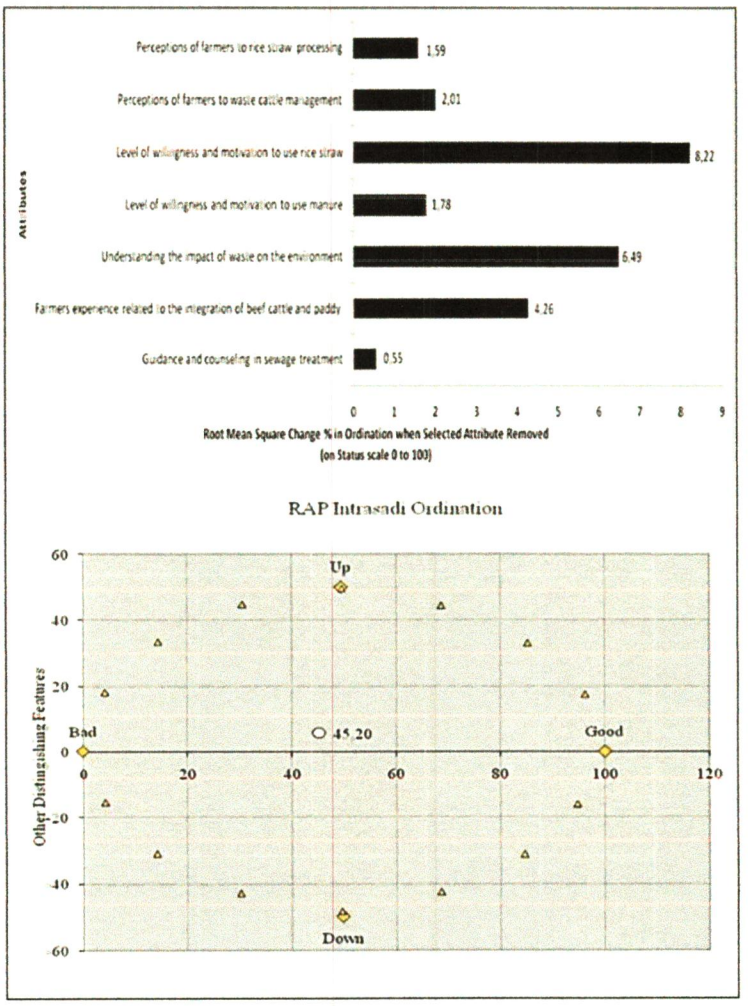

Figure 5. Leverage of sosial-culture attributes on sustainability score and indexofsustainability

The results of the RAP Intrasadi analysis showed that sustainability index for technological dimensions was 53.29 which indicated that the integration of beef cattle and paddy by farmers with sufficient ongoing status. Sustainability index and sensitive attributes in technology and farming systems can be

seen in Figure 6 Sensitive attributes in determining the sustainability of cow paddy dimensional integration technology were a) biogas processing facilities and infrastructure b) fertilizer processing facilities and infrastructure and c) application of cattle waste treatment technologies as biogas

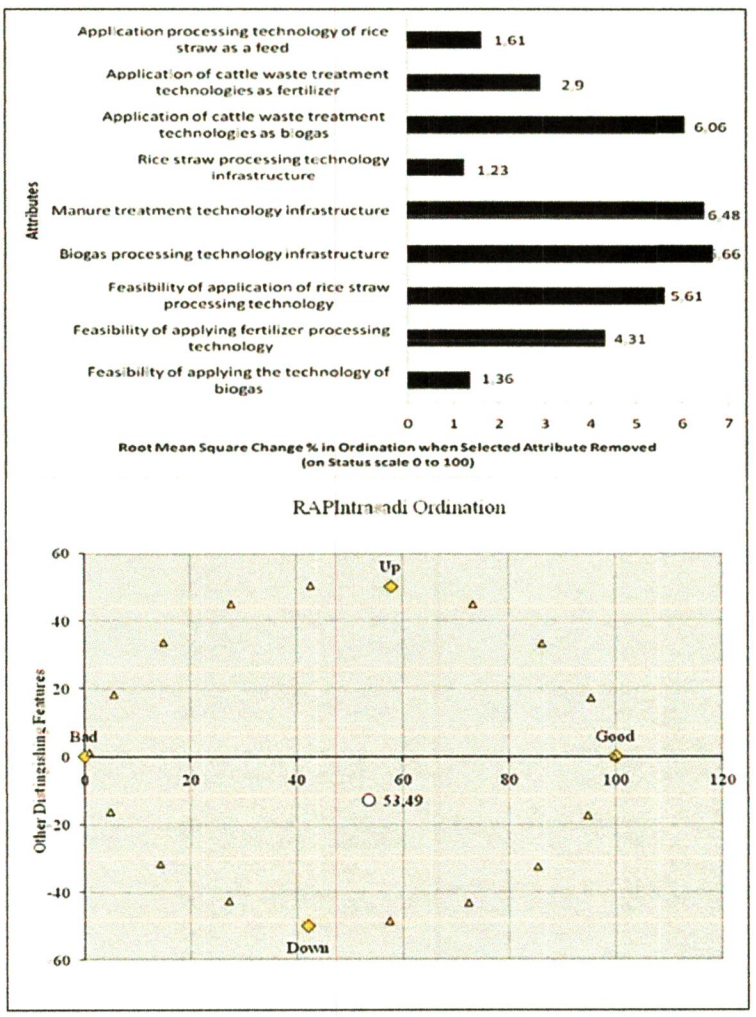

Figure 6 Leverage of technology attributes on sustainability score and index of sustainability

Efforts to improve the sustainability of beef and rice based integration technology through the development dimension supporting facilities for livestock waste into fertilizer and biogas The provision of home

composting infrastructure to process animal waste into fertilizer and biogas digester as the processor was the tool that is needed by farmers in the framework sustainability of integration beef cattle and paddy. Study of Mandal et al (2013) stated that the use of biogas in the household-level have potential to reduce gasses. This indicated that when this integration is adopted most of the farmers, the fate of environment in the future would be much better. Furthermore, it will contribute to improved health, wellbeing, and the long-term sustainability of organic farms (Kaufman and Watanasak, 2011).

4. Conclusions

Index sustainability in multidimensional of integration of beef cattle and paddy with technological innovation rice straw as feed, livestock manure as fertilizer and biogas were implemented by farmers with the value of46.12, it means that the status was less sustainable. To improve the sustainability status, each sensitive attribute in each dimension must be considered. Attributes that must be improved in each dimension is the dimension of ecology, a) potential and carrying capacity of livestock waste, b) potential and carrying capacity of rice straw, and c) management of cattle farming. Economic dimension, a) contribution of livestock waste biogas to fuel costs, b) the number and ownership of paddy fields, and c) the number and ownership of cattle, is a social dimension a) level of willingness and motivation to utilize rice straw, b) understanding the impact of waste on the environment, and c) the integration of related experience beef cattle and rice, as well as a technological dimension a) biogas processing facilities and infrastructure, b) fertilizer processing facilities and infrastructure, and c) application of cattle waste treatment technologies as biogas.

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