

Beef Cattle Sustainability Determinants Using Structural Equation Modeling in Pati Regency, Central Java

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ABSTRACT

The research objective was to create a structural model to link social, economic, and environmental variables to the sustainability of the beef cattle business. One hundred twenty beef cattle farmers in Pati Regency were taken as respondents. The exogenous variables studied were social, economic, and environmental factors. Endogenous variables were taken, namely beef cattle sustainability. The model was created using Structural Equation Modeling. The results show that social factors have a positive and significant effect on sustainability, while economic and environmental factors have a negative and significant effect. The net income obtained is low, and the investment return period takes nine years, nine months, and nine days. The number of beef cattle farmers who process dung is only 27.2%. To improve economic and environmental performance, it is necessary to provide training to improve skills in processing feed based on local resources and training in processing livestock manure into fertilizer and biogas.

Keywords: Beef Cattle, Economic, Environmental, Social, Sustainability.

INTRODUCTION

Beef cattle play a significant role in the Indonesian agricultural and livestock industries. Large consumption but not followed by an adequate amount of production has resulted in depletion of the number of beef cattle nationally. Indonesia is a country that imports very large beef cattle; almost every year, Indonesia has to import 70000-150000 tonnes of meat from Australia, Brazil, and even India. In order to reduce the number of imported beef, it is necessary to improve the cattle production system in Indonesia. The sustainability of the beef cattle business system needs to be done to ensure the success of the business system. Sustainability is influenced by three aspects, namely economic, social, and environmental factors. The increase in these three factors will cause the increase in beef cattle cultivation to run well.

Beef cattle sustainability is a way to increase production. Increased production will lead to a potential decline in meat imports from other countries. Research on agriculture sustainability has been carried out in several countries (Asem-Hiablie et al., 2018; Besser et al., 2021; Bilotto et al., 2021; Costantini et al., 2021; de Freitas et al., 2019; D'Occhio et al., 2019; Gathura et al., 2020; Modzelewska-Kapituła et al., 2021). Sustainability includes social factors (de Freitas et al., 2019; Lovarelli et al., 2020; Rustinsyah, 2019), economic factors (Galeana-Pizaña et al., 2021; Mazzetto et al., 2020; Zugravu-Soilita et al., 2021), and environmental factors (Li et al., 2020; Rotz et al., 2019; Santos et al., 2017).

To be able to make structural relationships between exogenous and endogenous variables in agriculture, some researchers use structural equation

modeling (SEM) (Senger et al., 2017; Szabo et al., 1999; Yang et al., 2021; Yasar et al., 2015; Yu et al., 2021). This study aims to create a structural model that connects exogenous variables of social, economic, and environmental factors and an endogenous variable of beef cattle sustainability.

METHODOLOGY

This research was conducted in Pati regency; 120 beef cattle farmers using a cow-calf system were observed using a structured questionnaire. The variables observed were social, economic, environmental factors, and an independent variable, namely the sustainability variable.

The measure for social factors, economic factor and sustainability was (5 = excellent, 4 = good, 3 = enough, 2 = bad, 1 = very bad). Environmental factors were measured by a dummy (0 = beef cattle farmers who did not process manure and 1 = beef cattle farmers who process manure).

The data were analyzed using descriptive and quantitative approaches. To connect social, economic, and environmental factors to beef cattle sustainability using Structural Equation Modeling analysis. Researchers used the TETRAD-IV software to complete the SEM.

RESULT AND DISCUSSION

As shown in Table 2, the cattle farmers were 52.6 years old on average. Most of them only graduated from elementary school, which accounted for 54.2%. Approximately 21% of respondents graduated from junior high school, 20.8% graduated from senior high school, and 4.2% graduated from university. Farmers have experienced in raising beef cattle for about 14 years. The number of cattle raised by farmers was 4.25 animal units (AU). The average daily gain (ADG) was 0.33 kg/day.

As shown in Table 3, all social factors have a good score. The roles of farmer group, farmer group head, extension agent, animal husbandry office and university academic staff members have a value greater than three. This condition means that, according to beef cattle farmers, all elements play a social role in advancing beef cattle farming.

As shown in Table 4, because all the respondents studied were cow-calf farmers, the investment needed was to build a stable and buy female beef cattle. The amount of investment was IDR 22,000,000.

Table 1
Research Indicator

No	Item	Indicator
1	Social	<ol style="list-style-type: none"> 1. Role of Farmer group 2. Role of farmer group head 3. Role of extension agents 4. Role of animal husbandry office 5. Role of university academics staff
2	Economic	<ol style="list-style-type: none"> 1. Income 2. Business feasibility 3. Production
3	Environment	<ol style="list-style-type: none"> 1. Farmer process the manure or not (1= if process, 0= if not)
4	Sustainability	<ol style="list-style-type: none"> 1. Social viable 2. Economic viable 3. Environment sound 4. Low risk 5. Productivity

Source: Processed from Primary Data

Table 2
Socio Characteristics Beef Cattle Farmer

No	Item	Number
1	Number of respondents	120
2	Age (year)	52.6
3	Educational background	
	Elementary (%)	54.2
	Junior high school (%)	20.8
	Senior high school (%)	20.8
	Undergraduate (%)	4.2
4	Experiences (year)	13.96
5	Number of cattle raised (AU)	4.25
6	Average daily gain (ADG) (kg)	0.33

Source: Processed from Primary Data

Table 3
Social Factor

No	Item	Score
1	Role of Farmer group	3.6
2	Role of Farmer group head	3.6
3	Role of extension agents	3.8
4	Role of animal husbandry office	3.6
5	Role of university academics staff	3.9

Source: Processed from Primary Data

Table 4
Investment of Beef Cattle Farming

No	Item	Number (IDR)
1	Beef cattle cage	4,000,000
2	Female Beef cattle	18,000,000
	Total	22,000,000

Source: Processed from Primary Data

As shown in Table 5, the amount of annual income earned was IDR 2,783,833. The total revenue earned during the year was IDR 8,583,750. The annual cost was IDR. 5,799,916.

As shown in Table 6, economic analysis is carried out to calculate the economic feasibility of beef cattle farming. The calculation of NPV, B/C ratio, PP, and IRR shows that economically the income earned was small, so it took a long time to return on investment.

As shown in Table 7, only 27.5% of the respondents processed their livestock manure. Some made fertilizer and biogas.

However, the majority of beef cattle farmers (72.5%) have not processed cow dung. Most of them directly sell cow manure.

Table 7
Environment Factor

No	Item	Percentage (%)
1	Number of farmers processed cattle manure	27.5
2	Number of farmers not processed cattle manure	72.5

Source: Processed from Primary Data

Table 5
Income Analysis

No	Item	Number (IDR)
1	Calf sold (IDR/year)	7,308,750
2	Manure sold (IDR/year)	1,275,000
	Total Revenue	8,583,750
3	Feed cost (IDR/year)	3,456,167
4	Labor cost (IDR/year)	1,918,750
5	Insemination cost (IDR/year)	425,000
	Total production cost (IDR/year)	5,799,916
6	Net Income (IDR/year)	2,783,833

Source: Processed from Primary Data

Table 6
Economic Analysis

No	Item	Number
1.	Net present value	2,387,707
2	B/C ratio	1.1
3	Payback period	9 years, 9 months, 9 days
4	Internal Rate of Return (IRR)	5.6%

Source: Processed from Primary Data

Figure 1 illustrates the structural relationship between existing latent variables and existing indicators. There was a significant relationship among social, economic, and environmental factors on the sustainability of beef cattle farming. As shown in Table 8, there is a positive influence between social factors on sustainability. This indicates that the increase in social factors has led to an increase in beef cattle sustainability, but economic and environmental factors have a negative effect. This indicates that economically the cow-calf beef business has not been able to provide decent profits for farmers. Only a small proportion of farmers process manure into fertilizer or biogas to influence environmental factors on sustainability.

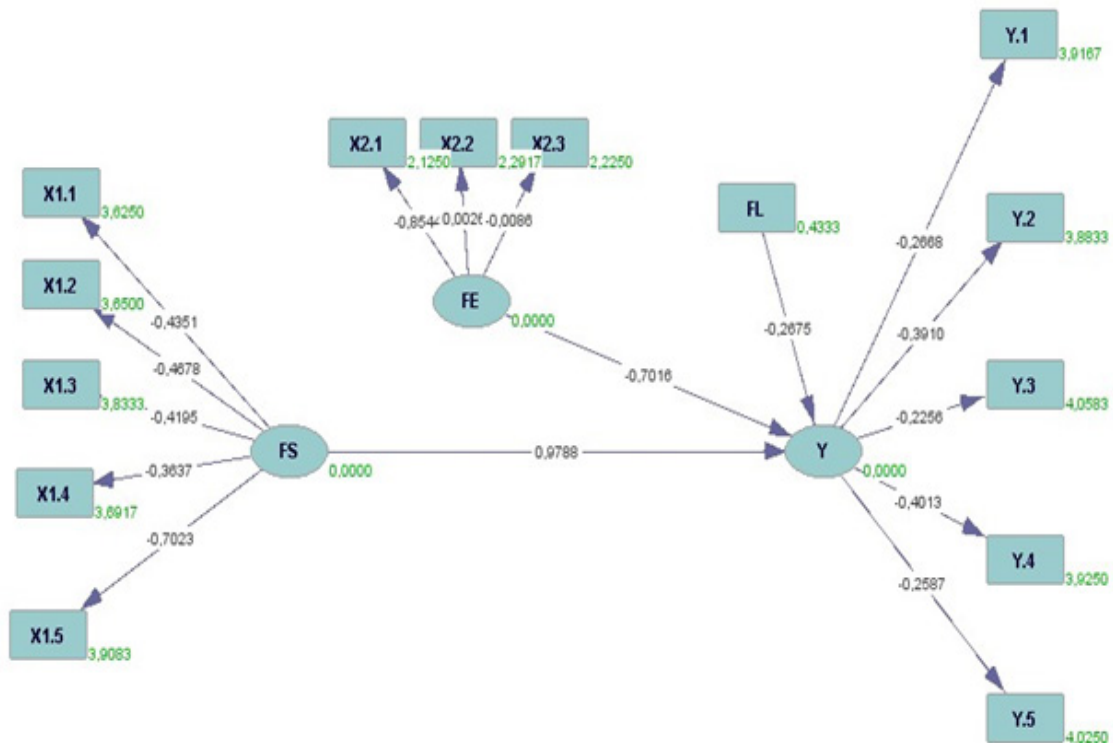
As presented in Tables 2, beef cattle farmers have low education on average, so that the role of the group and group leaders in increasing motivation to breed is essential. Prasara-A & Gheewala (2021) stated that social factors are essential variables in supporting sustainability. Lovarelli et al. (2020) stated that

social factors are essential to improve the livestock sector's performance. According to Li et al. (2020) and Lefore et al. (2021), social factors can increase farmer motivation and commitment. This increased motivation and commitment will cause farmers to adopt technological developments. Roobavannan et al. (2020) stated that social factors influence the sustainability of the agricultural sector, especially in climate change. Improvement of beef cattle maintenance management through extension agents, animal husbandry staff, and university academic staff is essential in the sustainability of the beef cattle business. Social factors significantly affect agriculture performance in several countries (Besser et al., 2021; Nguyen & Drakou, 2021; Santoso et al., 2017; Zugravu-Soilita et al., 2021)

Economically, the beef cattle business generates a small income, the investment invested will return in a long time, namely nine years, nine months, and nine days. The beef cattle sales system is also not running well. Usually, beef cattle farmers sell their products using an estimation

system instead of the weighing system. The former system potentially causes farmers in an unfavorable position. Compared with the marketing system in broilers, it is much more developed than the marketing system for beef cattle. ADG is also low at only 0.33 kg/day; this is due to the low quality of feed, especially when the dry season arrives; most farmers only provide rice straw as feed because the grass is difficult to find. Following the opinion of Santoso et al. (2016) and Santoso et al. (2017) studies, the way to increase ADG is by improving the quality of

feed. Improving ADG and beef cattle sales systems is a way to improve economic factors. Lovarelli et al. (2020) state that improvements in economic factors will cause agriculture sustainability to increase. Insemination costs are also quite high; the average service per conception is 2.4. This figure is relatively high because most farmers have to do artificial insemination 2-5 times before their cattle get pregnant. The efficiency of production costs needs to be done to improve the performance of economic factors.



Source: Processed from Primary Data

Figure 1
Structural Equation Modelling of Beef Cattle Sustainability in Indonesia

Table 8
Economic Determinants

From	To	Value	SE	t-value	p-value
FE	X2.1	-0,8544	0,0623	-13,7101	0.0000
FE	X2.2	0,0026	0,0895	0,0289	0.9770
FE	X2.3	-0,0086	0,0863	-0,1001	0.9204
FE (Economic factor)	Y (Sustainability)	-0,7016	0,1342	-5,2287	0.0000
FL (Environment Factor)	Y (Sustainability)	-0,2675	0,1871	-2,4301	0.0155
FS	X1.1	-0,4351	0,0814	-5,3457	0.0000
FS	X1.2	-0,4678	0,0886	-5,2786	0.0000
FS	X1.3	-0,4195	0,0775	-5,4106	0.0000
FS	X1.4	-0,3637	0,0887	-4,1000	0.0001
FS	X1.5	-0,7023	0,0766	-9,1645	0.0000
FS (Social factor)	Y (Sustainability)	0,9788	0,1231	7,9541	0.0000
Y	Y.1	-0,2668	0,0580	-4,5997	0.0000
Y	Y.2	-0,3910	0,0607	-6,4399	0.0000
Y	Y.3	-0,2256	0,0604	-3,7330	0.0003
Y	Y.4	-0,4013	0,0614	-6,5387	0.0000
Y	Y.5	-0,2587	0,0620	-4,1687	0.0001

Source: Processed from Primary Data

Environmental factors negatively affect beef cattle sustainability because only a low proportion of beef cattle farmers process manure. Lefore et al. (2021) and Li et al. (2020) state that there must be no environmental problems to be sustainable. Every person involved in the agricultural business must make efforts to treat the resulting waste. The percentage of farmers cultivating manure is only 27.5%. This number should be increased to improve environmental performance. Improvement of skills in managing manure can be made regularly by extension agents, university academic staff, and animal husbandry staff members.

Overall, the SEM model in this study is very good. All exogenous variables affect endogenous variables. It is necessary to improve the performance of economic factors and environmental factors in order

to increase beef cattle sustainability in Indonesia. Training on cheap feed making based on local resources and training on animal manure processing needs to be carried out by extension agents, university academic staff, and animal husbandry office staff.

CONCLUSION

SEM results show that social factors positively affect beef cattle sustainability while economic factors and environmental factors have a negative effect. In order to increase the productivity of beef cattle, it is necessary to improve the seeds and feed quality. An ADG value of only 0.33 indicates that the seeds and quality of the feed are not good. Training to process livestock manure into fertilizer or biogas needs to be done to increase environmental factors.

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