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Sustainability of cattle farming using analysis approach of Structural Equation Modeling (a study on dry land of Tanah Laut Regency, South Kalimantan, Indonesia)

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Abstract

The study was conducted in the village of Sumber Makmur and Central Banua, Takisung Sub-district, Tanah Laut Regency, South Kalimantan Province, Indonesia. This study aims to determine (1) factors influencing the sustainability of beef cattle farming (2) factors influencing the welfare of farmers, in form of a case study on the dry land. The study was conducted with survey method to 111 respondents using questionnaires that had been prepared previously (structured). The respondents were chosen by purposive sampling with criteria of having or farming beef cattle. The data were analyzed using Structural Equation Modeling (SEM), completion of the data was conducted using AMOS software. In this study, there are seven endogenous variables and two exogenous variables. The endogenous variables are environmental, economic, social, technology, physical, human, and institutional resources. The results show that environmental, economic, technological, physical, human, and institutional resources influence the sustainability of beef cattle farming; environmental, economic, technological, physical, human, and institutional resources influence, either directly or indirectly, the welfare of farmers (except social); and cattle farming sustainability variable influences the welfare of farmers. According to the result of this study, it is suggested that for the sustainability of beef cattle farming and to improve the welfare of farmers, several things that should be improved and considered are the improvements of resources, primarily environmental, economic, technological, physical, human, and institutional resources.

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Introduction

South Kalimantan is a province in Indonesia that is included in the eastern part of Indonesia in which the agricultural sector is one of the important livelihoods for the people. It can be seen from the number of agricultural households equal to 432,359 and the number of agricultural households in Tanah Laut Regency as many as 43,262 (Central Agency on Statistics of South Kalimantan, 2013a) and the growth rate in 2012 for the agricultural sector equal to 3.6 % (Central Agency on Statistics of South Kalimantan, 2013b). One of farming carried out by farmers in South Kalimantan is raising cattle, although it is still limited as subsistent one.

Increased demand for beef products in South Kalimantan must be balanced with some efforts through government programs. Strategies are required in their development supported by appropriate, efficient and effective technological innovations, and can be carried out by farmers both technically and socially. These opportunities are supported by the potential of natural resources which are still fairly open such as vast land and agricultural and agro industrial wastes that have not been optimally utilized as animal feed (Agency for Agricultural Research and Development, 2007).

World Commission on Environment and Development (WCED) in 1987, known as the Brundtland report, *Our Common Future* defines sustainable development as development that meets the needs of the present without sacrificing the ability of future generations to meet their own needs (WECD, 1987). The concept of sustainable development includes three main points, namely: economic, social, and ecological (Munasinghe, 1993; Drexhage and Murphy, 2010). Agricultural sustainability refers to the ability of agriculture to produce food without limits, without causing irreversible damage to the ecosystem (Asadi *et al.*, 2013). From the study conducted by Asadi *et al.* (2013) in Iran, it is known that the ecological, social, and economic aspects provide positive effects on sustainable agriculture. The results of his research can help agriculture planners and policymakers identifying appropriate policies and monitoring the effectiveness of those policies. At first, aspects assessed in sustainable agriculture were only 3 pillars or dimensions, namely ecological, economic and social. Then they were developed and accomplished by other dimensions such as technological, institutional, legal, human resources and others as reported by several studies such as the studies conducted by Suyitman *et al.* (2009), Nazam (2011) and Rois (2011).

SEM is the integration between two statistical concepts, namely the concept of factor analysis belonging to measurement model and the concept of regression through structural model. The measurement model explains the relationship between variables and their indicators and the structural model explains the relationship among variables. The measurement model is a study of psychometrics, and the structural model is a study of statistics. SEM is an evolution of multiple equation models (regression) developed from the principle of econometrics and combined with the principle of settings (factor analysis) of psychology and sociology (Hair *et al.*, 1995).

This study aims to analyze (1) factors influencing the sustainability of feed cattle farming (2) factors influencing the welfare of farmers, in Tanah Laut Regency, South Kalimantan, Indonesia.

Materials and methods

Research settings

The study was conducted in the village of Sumber Makmur and Central Banua, Takisung Sub-district, Tanah Laut Regency, South Kalimantan, Indonesia. The location was chosen with consideration that it was the basis of beef cattle farming and due to its the vast dry land. The study was conducted from June to December 2012.

Sampling techniques and data collection

The method used in this research was a survey method. Primary data was obtained through

interviews with farmers using questionnaires that had been prepared previously (structured). The technique used in determining respondents to collect information in the study was by particular consideration (purposive). The respondents selected were those who had or bred beef cattle. In general, the farming of beef cattle is carried out to local cattle i.e. Bali cattle and Ongole Crossed Cattle *(PO)*. The number of respondents in this study were 111 people coming from the village of Central Banua as many as 52 people and 59 people from the village of Sumber Makmur, Takisung Subdistrict, Tanah Laut Regency, South Kalimantan, Indonesia.

Data analysis

The data was analyzed using Structural Equation Modeling (SEM) to examine two endogenous variables as follows :

1. To examine the effects of environmental, economic, social, technological, physical, human, and institutional resources on the sustainability of cattle farming
2. To examine the effects of environmental, economic, social, technological, physical, human, institutional resources and cattle farming sustainability on the welfare of farmers

The observed variables are shown in Table 2. For the completion of data, AMOS software is used.

Table 1: Variables observed in the study

Variables	***Indicators***		***Number of Itemize***
Environmental Resources (X1)	X11	Utilization of Waste	2
	X12	Level of Pollution	2
	X13	Quality Supporting Environment	4
Economic Resources (X2)	X21	Financial Institutions	3
	X22	Sources of Capital	3
Social Resources (X3)	X31	Communication Relationship	6
	X32	Cooperation	3
Technological Resources (X4)	X41	Mastery of Technology	5
	X42	Mastery of Livestock Management	3
Physical Resources (X5)	X51	Asset Ownership	4
	X52	Availability of Means of Production	4
Human Resources (X6)	X61	Labor	4
	X62	Education Level	4
Institutional Resources (X7)	X71	Quality of Organization/ Group	5
	X72	Institutional Relationships	7
Cattle Farming Sustainability (Y1)	Y11	Quantity of Cattle Farming	3
	Y12	Quality of Cattle Farming	3
Welfare of Farmers (Y2)	Y21	Incomes	8
	Y22	Savings	2
	Y23	Life Quality	4

Results and Discussion

Characteristics of respondents

Based on the survey and Focus Group Discussion (FGD) conducted with community leaders, it was known that there were some common or quite dominant patterns of farming which were performed by farmers in Tanah Laut Regency. Patterns of farming carried out consisted of food crops, secondary food crops *(Palawija)* and beef cattle. This reflected that the farmers in the research site carried out diversification with several commodities that were conducted integratedly. Characteristics of the respondent farmers observed in this study were categorized according to age, education, experience, land area, members of household and number of cattle ownership.

Table 2: Characteristics of the respondent farmers in the Subdistrict of Tanah Laut

No	*Respondents Characteristics*		*Total*	*Percentage*
1	Age (years old):			
	a.	20-30	7	10.29
	b.	31-40	18	26.47
	c.	41-50	22	32.35
	d.	51-60	13	19.12
	e.	> 60	8	11.76
2	Education (years old):			
	a.	Not studying at school (0)	2	2.94
	b.	Elementary School (1-6)	31	45.59
	c.	Junior High School (7-9)	22	32.35
	d.	Senior High School (10-12)	8	11.76
	e.	> 12	5	7.35
3	Experience (years old):			
	a.	1-10	24	35.290
	b.	11-20	28	41.180
	c.	21-30	10	14.710
	d.	> 30	6	8.820
4	Land Area (ha):			
	a.	< 1	3	4.41
	b.	1-2	24	35.29
	c.	2-3	21	30.88
	d.	> 3	20	29.41
5	Household Members (people):			
	a.	1-2	6	8.82
	b.	3-4	41	60.29
	c.	>4	21	30.88
6	Number of Cattle (AU)			
	a.	<4	29	39.71
	b.	4-5	32	47.06
	c.	>5	9	13.24

From the results of study, it is obtained that the age of most farmers is included in the productive age (20-60 years old), equal to 88.24 % and the remaining 11.76 % is elderly (over 60 years old) ranging from 25 to 70 years old (Table 2). The number of farmers included in the productive age shows a positive thing, meaning that farming is still favored and becomes the major work. The productive age group is still potential to develop themselves and develop their farming. Age is one of the important characteristics of farmers, because age has a relationship to experience, work ability, and psychological maturity. Farmers having older age possess more experiences and they are psychologically mature. By this condition, it is assumed that farmers would master how to manage their works.

The education level of respondent farmers is still categorized low, as shown by farmers who do not study at schools (2.94%) and most of them are in the level of elementary school (45.59%) and junior high school (32.35%) (Table 2). It indicates that the dominant level of education of farmers is elementary school, thus, the behavior and procedures in managing their farming are relatively simple. The low level of farmers' education in Indonesia describes the low ability of farmers to send their children to schools and education has not been given priority. It is probably caused by limited income. The low education level of farmers is feared to degrade the quality of agricultural sector as farmers are not responding to the demands of market (Harijati, 2007). Education serves as a process to explore and control the existing potential to be developed and utilized for the improvement of life quality (Tilaar, 1997).

The range of experience of the respondent farmers is between 2-44 years, and the largest percentage of farmers' experience is in the range of 10-20 years, which are equal to 41.180% farmers. Total farmers whose experience is over 10 years are 64.710% and the remaining are 35.29% with under 10-year experience (Table 2). Experience is one way to learn and find knowledge, therefore, by a lot of experiences, the learning process and knowledge possessed by the respondent farmers will relatively increase.

Land is one of the important capitals in doing farming, belonging to one of production factors. Land is the physical resources that have a very important role for farmers. The results of this study show that the land area owned by farmers is mostly above 1 ha, owned by 95.59 % farmers, and the remaining 4.41% farmers own below 1 hectare land area. The largest area of land owned by farmers is between 1-2 hectare/household (Table 2). Land area owned by farmers in this study is relatively broader compared to farmers in Central Lombok as reported by Puspadi *et al.* (2012), i.e. the average of 0.39 hectare with a range between 0.20 to 2.00 hectare.

The largest household members range from 3-4 people/household, that is 60.29% (Table 2). If household members are involved in farming activities, labors from outside the family are still required. If family labors are available, in general, farmers only utilize women labor (mother or wife) in families to help the farming, while child labors are not highly utilized although they are above 15 years old since the study. The result of study conducted by Ilham *et al.* (2007) states that from the results of agricultural census of 2003, there were 45-85% of families having about 3-4 people of household members. This fact indicates that farmers' family are concerned with their quality of life. Household members can help in doing production activities to meet the needs of life and become potential sources of family labor for beef cattle raising. Labor availability definitely influences the success of farming systems. From research conducted in Central Kalimantan, it is found that the average of family labors are 5.30 people with a range of 3 to 11 people per farmer household. The condition indicates that sufficient manpower is available for farmer households (Utomo *et al.*, 2004). Based on several research, it is stated that household members are getting smaller, this indicates that family labors that can be utilized are also limited, therefore, it is needed labors from

outside or the development of use of agricultural mechanization.

The number of cattle raising, mostly between 4-5 AU/ household is 47.06% and below 4 Animal Unit (AU) is 39.71%, and for the one above 5 AU is only 13.24 %. When averaged, the cattle ownership is 4.12 AU, farmers who have the most cattle are in farming pattern 6 (rice, corn and cattle) which is 5.15 AU and the smallest are in farming pattern 1 (rice and cattle) which is 3.50AU (Table 2). Cattle owned by respondent farmers consist of groups of calf, virgin, and adult cattle. In general, number of cattle raised by farmers is relatively stable from year to year due to the reason that the number of cattle that are too large would require larger time and cost, therefore, when the number of animals are increased due to births, most farmers will sell some of their cattle. Sales of cattle are also the source of family income that contributes to the family income.

Research instrument testing

This study uses a questionnaire instrument. It is necessary to test the validity and reliability of the instrument. Instrument validity testing uses Pearson correlation coefficient, and the instrument reliability testing uses Cronbach alpha coefficient. Correlation values are all above 0.30, and alpha values are all above 0.60, thus, the instrument has met the assumptions of validity and reliability of the instrument. The outcome data of instrument are feasible for further analysis.

SEM analysis: measurement model

There are two models in SEM analysis, namely measurement model and structural model. Measurement model in SEM is equivalent to Confirmatory Factor Analysis. Factor loading value indicates the weight of each indicator as the gauge of each variable. Indicator with the biggest loading factor indicates that this indicator is as the strongest (dominant) variable gauge.

Based on the analysis, it is obtained that all the resources used in this study have P-value <0.05 or the indicator is stated to be fixed (set), meaning that it has a real impact. Environmental resource variable (X1) consists of three indicators, namely utilization of waste (X1.1), level of pollution (X1.2), and quality supporting environment (X1.3). Results of Confirmatory Factor Analysis towards indicators of the environmental resource variable (X1) are presented in Table 3. The analysis shows that all three indicators significantly measure the environmental resource variable (X1) for each indicator has P-value <0.05 or the indicator is stated to be fixed (set). The highest loading factor coefficient indicates that the indicator of quality supporting environment (X1.3) is the strongest indicator of the environmental resource variable gauge (X1). The indicators of quality supporting environment are in form of pasture availability, availability of slaughter house *(RPH)*, the level of productive female cattle slaughtering and the fertility of land due to the use of organic fertilizers. Environmental quality will be better if pasture is available as one of feed availability place. Slaughter houses guarantee the existence of Veterinary Public Health upon the product of cattle slaughtered with the insight of safe, healthy, wholesome and halal *(ASUH)* compared to cattle slaughtered not at slaughter houses or not at the right place. Productive female cattle slaughtering influences sustainability of environment aspect because if the slaughtering of productive female cattle is not controlled, the population growth and quality of beef cattle will be threatened. The use of organic fertilizers on soil fertility influences the sustainability of environmental aspect. Fertile land will produce good products with good and efficient quality including the planted fodder bank.

Table 3. The results of CFA testing on resources variables which are observed

Variables	*Indicators*	*Loading Factor*	*P-value*
Environment (X1)	Utilization of Waste (X1.1)	0.67	Fixed
	Level of Pollution (X1.2)	0.55	0.00
	Quality Supporting Environment (X1.3)	0.71	0.00
Economic (X2)	Financial Institutions (X2.1)	0.96	Fixed
	Sources of Capital (X2.2)	0.72	0.00
Social (X3)	Communication Relationship (X3.1)	0.91	Fixed
	Cooperation (X3.2)	0.56	0.00
Technology (X4)	Mastery of Technology (X4.1)	0.72	Fixed
	Mastery of Livestock Management(X4.2)	0.87	0.00
Physical (X5)	Asset Ownership (X5.1)	1.07	Fixed
	Availability of Means of Production (X5.2)	0.47	0.02
Human (X6)	Labor (X6.1)	0.60	Fixed
	Education Level (X6.2)	0.87	0.00
Institution (X7)	Quality of Organization/ Group (X7.1)	0.63	Fixed
	Institutional Relationships (X7.2)	0.84	0.00

Economic resource variable (X2) consists of two indicators, namely indicators of financial institutions (X2.1) and sources of capital (X2.2). The result of Confirmatory Factor Analysis (CFA) on indicators of economic resource variables (X2) is shown in Table 3. Both indicators significantly measure economic resource variable (X2) for each indicator has P-value < 0.05 or the indicator is stated to be fixed (set). The coefficient of highest factor loading indicates that the indicator of financial institutions (X2.1) is the strongest indicator of economic resource variable (X2) compared to capital sources (X2.2). Financial institutions in this context are the existence of financial institutions at the village level (groups and farmer group association/*gapoktan*) which can be accessed by farmers in supporting their capital, the existence of access to obtain loans from banks or cattle loans from government institutions. The results of this study show that farmers gain access to capital loans from financial institutions in the village, the Bank or financial aid in form of cattle so that the cattle farming carried out from the economic aspect is sustainable. It is in line with the study conducted by Rois (2011) stating that the availability of farming business capital is derived from personal or loan of microfinance institutions to support sustainable agriculture.

Social resource variable (X3) consists of 2 indicators, namely indicators of communication relationship (X3.1) and cooperation (X3.2). The results of Confirmatory Factor Analysis on the indicator of social resource variable (X3) is indicated by the presence of communication relationship and cooperation. Both indicators significantly measure social resource variable (X3) for each indicator has P-value < 0.05 or the indicators are stated to be fixed (set). From the highest loading factor coefficient, it is obtained information that the indicator of communication relationship (X3.1) is the strongest indicator compared to cooperation (X3.2). Indicators included in the communication relationship are relationship and communication with offices, extension workers, research institutes, financial

institutions, village institutions, and animal health center (*Puskewan*). The better the communication relationship with these institutions will ensure the sustainability of the social aspect. Offices, extension agencies, research institutes, financial institutions and animal health center provide information both technical/ non-technical, facilities and assist farmers in managing cattle farming. This is supported by Rois' research (2011) stating that in order to achieve sustainable agriculture, it is required the active role of agricultural extension agencies, the active role of farmers and farmer groups, research institutes and Higher Education Institutions.

Technology resource variable (X4) consists of two indicators, namely indicators of mastery of technology (X4.1) and mastery of management of livestock/ knowledge (X4.2). The analysis results show that both indicators significantly measure technology resource variable (X4) for each indicator has P-value < 0.05 or the indicator is stated to be fixed (set). From the highest loading factor coefficient, it is obtained information that the indicator of livestock management mastery (X4.1) indicates the strongest indicator of technological resources variables gauge (X4) compared to technology mastery (X4.2). Farmers can master the livestock management mastery better such as cattle disease prevention, lair age capacity and estimating cattle body weight if they will be sold. For the technology information such as cattle farms quality, feed technology, reproduction, handling/ treatment of disease and lair age technology, if farmers need these, they will ask for the help from livestock technical personnel/ extension workers.

Physical resource variable (X5) consists of two indicators, namely indicators of asset ownership (X5.1) and availability of means of production (X5.2). Table 3 shows that both indicators significantly measure physical resource variable (X5). The highest loading factor coefficient of asset ownership indicator (X5.1) is the strongest indicator of physical resources variable gauge (X5). Factors measured from asset ownership is the existence of lair age, means of transportation, communication equipment, land ownership, land use and availability of water resources. These factors have more effects on the sustainability than physical resources aspects.

Human resource variables (X6) consists of two indicators, namely indicators of labor (X6.1) and education level (X6.2). Table 3 shows that both indicators significantly measure human resource variable (X6). The highest loading factor coefficient is derived from level of education (X6.1) meaning that it is the strongest indicator of human resource variable gauge (X6). Educational levels measured are formal and informal education of farmers and their family and farming experience. Good levels of education, presence of informal education and long time experience will be a good influence on the sustainability of human resources aspect compared to labor supply.

Institutional resources variables (X7) consists of 2 indicators, namely indicators of organization/ group quality (X7.1) and institutional relationships (X7.2). The analysis results of Table 3 show that both indicators significantly measure institutional resource variable (X7) for each indicator has P-value < 0.05 or the indicator is stated to be fixed (set). Institutional relationships have the highest loading factor coefficient, indicating that it is the strongest indicator compared to the quality of organization/ institution (X7.2). Institutional relationships in this study have more powerful effects. What are seen in these institutional relationships are relationships with financial institutions, extension workers, inseminator, cattle medics, cattle traders, other groups and marketing agencies. This study shows that institutional relationships influence the institutional sustainability. This is supported by Rois' research (2011) in West Kalimantan stating that the availability of institution (micro finance, agricultural extension services, research institutes support and Higher Education Institutions) supports for sustainable agriculture in form of : (1) cropping pattern and improving cropping index, (2) the maintenance of cattle, (3) the availability of farming capital, (4) the

availability of microfinance institutions, (5) the active role of agricultural extension services, (6) active participation of farmers and farmer groups, (7) support of research institutes and Higher Education Institutions, and (8) post harvest management and products marketing.

Cattle farming sustainability variable (Y1) consists of indicators of cattle farming quantity (Y1.1) and cattle farming quality (Y1.2). Table 4 shows that the indicators significantly measure cattle farming sustainability variable (Y1) for each indicator has P-value <0.05 the indicator is stated to be fixed (set).

The highest loading factor coefficient is derived from cattle farming quantity indicator (Y1.1), which is the strongest indicator of cattle farming sustainability variable gauge (Y1). Sustainability of cattle farming will be ensured if cattle farming quantity indicator such as the number of cattle that are raised, the number of non cattle that are raised and the incidence of cattle disease is well managed by farmers.

Tabel 4: The results of CFA testing on the variables of cattle farming sustainability and the welfare of farmers

Variables	***Indicators***	***Loading Factor***	***P-value***
Cattle Farming Sustainability (Y1)	**Quantity of Cattle Farming(Y1.1)**	**0.90**	Fixed
	Quality of Cattle Farming(Y1.2)	0.56	0.00
Welfare of Farmers (Y2)	**Income(Y2.1)**	**0.77**	Fixed
	Saving(Y2.2)	0.57	0.00
	Quality of Life (Y2.3)	0.69	0.00

Farmer welfare variable (Y2) consists of 3 indicators namely income indicator (Y2.1), savings (Y2.2), and quality of life (Y2.3). The welfare of farmers (Y2) is indicated from income, savings, and quality of life, and the results of analysis show that the indicators significantly measure farmer welfare variable. From the highest loading factor coefficient, it is obtained information that the indicator of income (Y2.1) is the strongest indicator of farmers welfare variables gauge (Y2). Sustainability of farmers' welfare is strongly influenced by income indicator such as cattle farming profits, income contribution of cattle origin, source of family income, nominal value of cattle origin, the amount of non-farming income and adequacy of income over expenditure of family income. Income indicator is more primary because it is used for expenditures. Life quality indicator also provides a big effect on the welfare of farmers, in form of family health, nutritional status of family, and the comfort and ownership of house. Savings indicator provides smaller effect, this is because farmers will be more concerned with the quality of family life, if there is surplus of income, farmers will save it. This is supported by the statement of Asadi *et al.* (2013) stating that the income/ revenue of farmers is the important factor in achieving sustainable agriculture.

SEM analysis: structural model

Structural model in SEM is identical to relationship among variables hypothesis testing. Hypothesis testing of direct effects is conducted using CR (Critical Ratio) testing on each line of direct effect partially. If the value of CR > 1.96 or P < 0.05, it can be concluded that there is a significant effect, if the value of CR <1.96 or the value of P > 0.05, then there are effects. Table 5 presents the results of direct effect hypothesis.

Table 5. Results of direct effects hypothesis testing

No	Relationships	Coefficient	CR	P
1	X1 to Y1	0.24	2.35	0.02*
2	X2 to Y1	0.19	2.11	0.04*
3	X3 to Y1	0.01	0.13	0.89
4	X4 to Y1	0.32	3.12	0.00*
5	X5 to Y1	0.20	1.76	0.08*
6	X6 to Y1	0.26	2.52	0.01*
7	X7 to Y1	0.29	2.51	0.01*
8	X1 to Y2	0.23	1.98	0.05*
9	X2 to Y2	0.16	1.75	0.08*
10	X3 to Y2	0.16	1.63	0.10
11	X4 to Y2	0.04	0.33	0.74
12	X5 to Y2	0.14	1.26	0.21
13	X6 to Y2	0.13	1.10	0.27
14	X7 to Y2	-0.01	-0.06	0.95
15	Y1 to Y2	0.62	2.32	0.02*

Remark: * Significant

In table 5 there are 6 lines of 15 lines that are not significant in overall, while 9 other lines are significant. Sustainability of cattle farming (Y1) is directly affected by the environmental resources (X1), economic resources (X2), technological resources (X4), physical resources (X5), human resources (X6), and institutional resources (X7). The highest CR value is resulted from technological resources (X4) equal to 3.12, human resource (X6) equal to 2.52, meaning that the sustainability of beef cattle farming is strongly affected by the technological and human resources, although other resources provide real effects except social resources. Technology providing effects in this study are cattle farms, feed, reproduction, diseases, lair age and knowledge of estimating animal body weight.

The welfare of farmers (Y2) is directly affected by the environmental resources (X1), economic resources (X2), and cattle farming sustainability resource (Y1), but not influenced by social resources (X3), technological resources (X4), physical resources (X5), human resources (X6), and institutional resources (X7), whereas social resources do not provide a significant effect. Furthermore, if viewed from the coefficient value, it can be seen that technological resources (X4) have a dominant effect on the sustainability of the cattle farming (0.32).

Environmental resources (X1) provide the most dominant effect on the welfare of farmers because the highest coefficient value (0.23). The study reported by Asadi *et al.* (2013) stating that environmental resources provide dominant effect (0.642) on sustainable agriculture compared to economic and social. This result is in line with the study reported by Ridwan (2006) asserting that the socio-cultural dimension has a low value on sustainability of livestock agribusiness in Bogor.

Based on the direct effect testing (Table 5), of the fifteen direct effects, there are six direct effects which are not significant (the third relationship) social resources (X3) on sustainability of cattle farming (Y1), (the tenth relationship) social resources (X3) on the welfare of farmers (Y2), (the eleventh relationship) technology resources (X4) on the welfare of farmers (Y2), (the twelve relationship) physical resources (X5) on the welfare of farmers (Y2), (the thirteenth relationship) human resources (X6) on the welfare of farmers (Y2), and (the fourteenth relationship) institutional resources (X7) on the welfare of farmers

(Y2). The results of SEM analysis are shown in Figure 1.

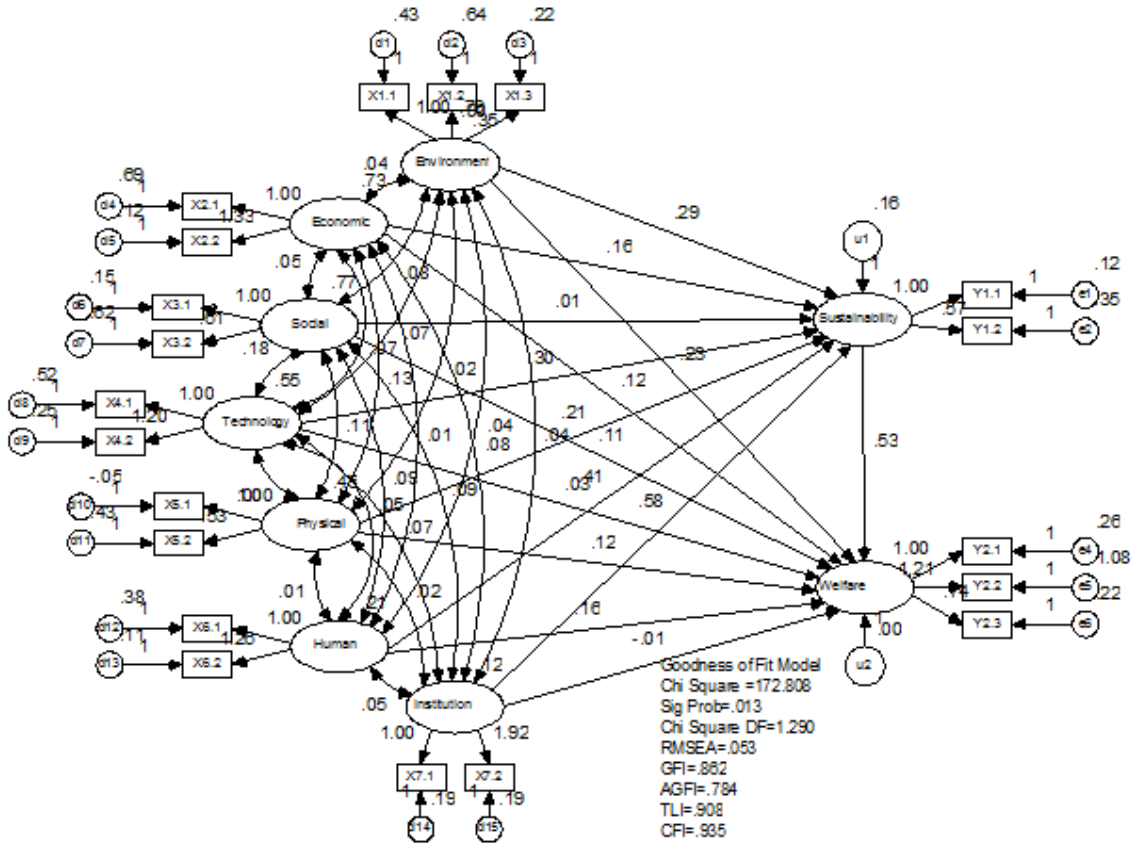

Fig. 1. The results of SEM analysis, the effect of resources on the sustainability of cattle farming and the welfare of farmers**.**

Based on this research, policies carried out to support sustainable agriculture and particularly sustainable beef cattle farming is carried out from the six above-mentioned aspects so that they can be focused and improve the welfare of farmers in accordance with the objectives of agricultural development in Indonesia, that is to improve the welfare of farmers. The research conducted by Asadi *et al.* (2013) in Iran shows that the sustainability of ecological, social, and economic aspects provide positive impacts on agricultural sustainability, nevertheless, the sustainability of ecological aspect has a greater effect on the sustainability of agriculture (0.640) rather than economic (0.600) and social sustainability (0.570).

Results of research conducted by Sitepu (2007) in D.I. Yogyakarta, Indonesia, on sustainable dry land management design with a gender perspective using Multidimensional Scaling (MDS) analysis, it shows that the index value of dry land management sustainability is classified into poor category to fair, thus, it is required management strategies in order to increase the sustainability in ecological, social and economic dimensions. The results of other research conducted by Rois (2011) in Kubu Raya Regency, West Kalimantan, Indonesia, showing that the sustainability status for five dimensions of sustainability in existing conditions indicate that at two research sites in Sungai Ambangah and Pasak Piang River Villages, the index value for institutional dimension is quite sustainable while other dimensions such as ecological, economic, social,

cultural and technological dimensions show less sustainable results. Another study reported by Suyitman *et al.* (2009) in Situbondo Regency regarding livestock-based region sustainability, it is obtained that ecological, legal and institutional dimensions are considered less sustainable, and for economic and social dimensions, they are categorized fairly sustainable. Some of the studies provide various results so that the solutions or policies of resolutions are different for each study sites.

Then, it is conducted indirect effect testing, in which it is conducted from some results of direct effect testing. Effect coefficients are not directly obtained from the result of multiplication of two or more direct effect coefficients that form it. Indirect effect is stated significant if the two coefficients of direct effect or all direct effect that form them are significant.

The testing results of indirect effect in Table 6 show that the welfare of farmers (Y2) is affected by environmental resources (X1), economic resources (X2), technological resources (X4), physical resources (X5), human resources (X6), and institutional resources (X7) through intermediary of sustainable cattle farming (Y1). In this study, an aspect which does not provide impacts significantly is social. The result of study reported by Rois (2011) and Mersyah (2005) states that the social dimension has low value of sustainability compared to other dimensions (economic and social).

Table 6. The result of research hypothesis testing of indirect effects of SEM

No	Relationhips	Coefficient
1	X1 to Y2 through Y1	0,15*
2	X2 to Y2 through Y1	0,12*
3	X3 to Y2 through Y1	0,01
4	X4 to Y2 through Y1	0,20*
5	X5 to Y2 through Y1	0,13*
6	X6 to Y2 through Y1	0,17*
7	X7 to Y2 through Y1	0,18*

Remark: * Significant

This study results indicate that it is required to improve the sustainability of feed cattle farming in order to improve the welfare of farmers, especially in term of environmental, economic, technological, physical, human, and institutional resources. If the welfare of farmers increases, it is assumed that poverty can be reduced. A form or model of sustainable agriculture is the one carried out in integrated manner (diversification) between crops and animals as it can provide several benefits such as: (a) reducing erosion; (b) improving crop yields, soil biological activity and nutrient recycling; (c) intensifying land use, increasing profits, and (d) helping reducing poverty and malnutrition and strengthening environmental sustainability (Gupta *et al.*, 2012). These results are supported by a study reported by Cooprider *et al.* (2011) stating that diversifications have high value on sustainable agriculture. Rois' study (2011) recommending policies formulated from sustainable research in West Kalimantan also recommends the raising of cattle to complement the farming.

Conclusions and suggestions

Based on the research and analysis conducted, it can be concluded that :

1. Factors that directly affect the sustainability of farming are environmental, economic, technological, physical, and human resources
2. Factors that affect either directly or indirectly the welfare of farmers are environmental, economic, technological, physical, human, and institutional resources
3. Technological resources have the most dominant effect on the sustainability of beef cattle farming and environmental resources are the most dominant in affecting the welfare of farmers
4. Suggestions from this study to achieve sustainable beef cattle farming in order to improve the welfare of farmers are the improvement of resources primarily environmental, economic, technological, physical, human, and institutional resources.

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