

# The Effect of Resources on Institutional Performance and Vulnerability Aspects of Dairy Cattle Businesses

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**Abstract.** This study aims to examine the effect of resources on institutional performance and the vulnerability aspects of dairy farming. It was conducted on June to September 2019 in Malang, Indonesia. The respondents are breeders who are members of the KUB (Joint Business Group) Tirtasari Kresna Gemilang institutional dairy cows, totaling 174 people. The research variables consist of economic resources (X1), environmental resources (X2), social resources (X3), institutional performance (Z), and aspects of vulnerability of livestock businesses (Y). The survey was conducted by interview and filling out the questionnaire using a Likert scale. The results showed that institutional performance was influenced by economic, environmental and social resources by 39.4%, while the aspect of livestock business vulnerability was influenced by institutional performance and economic, environmental and social resources by 23.9%. It shows that the strength of resources supported by institutional performance can reduce aspects of the vulnerability of livestock businesses

**Keywords:** resources, institutional performance, business vulnerability, dairy cows.

## 1 Introduction

The government seeks to increase domestic milk production by regulating partnerships through the use of domestic fresh milk by businesses that produce processed milk. These efforts are listed in the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 33 / PERMENTAN / PK.450 / 7/2018 concerning the supply and distribution of milk. The impact of this policy is that farmers are encouraged to collaborate in partnership so that milk produced by livestock can be absorbed by industry.

One of the partnerships is through the institution of dairy farmers. The role of the institution can function as a preventive measure against aspects of business risk and also have an impact on the achievement of livestock business development[1]. Livestock business development is influenced by farmers' access to resources [2]. Resources have an important role in livestock business[3], [4]. The greater the resources, the greater the potential for livestock business development[3]. These resources include financial, technological, physical, economic, environmental and social resources [4]. Resources can influence the development of livestock businesses [3]. The development of livestock business is beneficial to reduce aspects of business risk[5]. Livestock business development and business risk aspects are closely related to institutional performance[1]. That is because the greater the livestock business resources, the lower the aspect of livestock business vulnerability[6].

Vulnerability aspects in dairy cattle business are hazard conditions (both natural and artificial hazards) that can pose a risk of loss in dairy cattle businesses[7]. One effort to reduce the vulnerability aspect is to improve the institutional performance of dairy cows. The institution of dairy cows as research objects is the Tirtasari Kresna Gemilang Joint Business Group (KUB) of Tirtasari Kresna Gemilang in Malang Regency, East Java Province. Malang Regency was determined as the National Dairy Farm Area (KPSPN) based on the Decree of the Minister of Agriculture of the Republic of Indonesia in 2015 Number 43 / Kpts / PD.010 / 1/2015. The Joint Business Group (KUB) of Tirtasari Kresna Gemilang is a legal dairy cow institution and has a Legal Entity Number 00110084-AH.01.07 which was established in 2017 with an office location in Ngabab Village, Pujon District. KUB Tirtasari Kresna Gemilang has 174 members of dairy farmers. The institution is active in supporting the welfare of farmers and the community. The efforts of KUB Tirtasari Kresna Gemilang in supporting the welfare of farmers and the community are to utilize all the potential available resources. The purpose of this research is to map the resources of dairy cattle business and examine its effects on institutional performance and aspects of vulnerability. These resources are economic, environmental and social resources. The study was conducted in June to September 2019. The research hypothesis is that resources have a positive effect on institutional performance, but have a negative effect on vulnerability. Institutional performance has a negative effect on the aspect of vulnerability.

## 2 Research Method

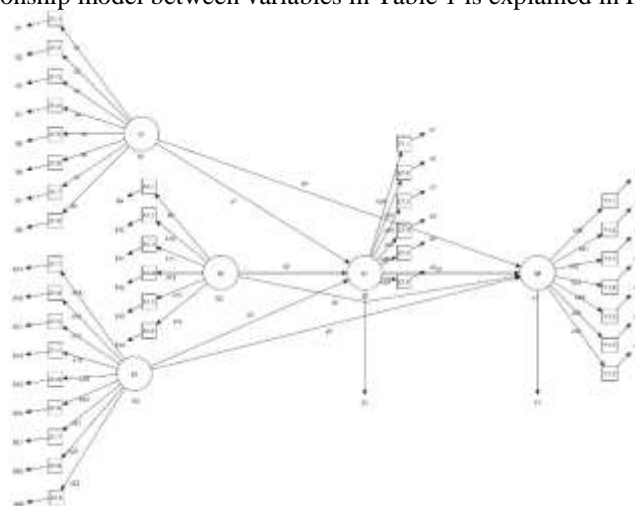
The study was conducted using an expost facto research approach. The data collection process was carried out from June to September 2019 at the Joint Business Group (KUB) of Tirtasari Kresna Gemilang. The research location was chosen by purposive sampling with the consideration that Malang Regency is one of the national dairy cattle development areas. Respondents are all dairy farmers who are members of KUB Tirtasari Kresna Gemilang, totaling 174 people (total sampling). The research data were obtained using FGD (focus group discussion), observation, and survey methods. The survey was conducted by interview and filling out questionnaires with a Likert scale of +1 to +5. The research variables consist of economic resources ( $X_1$ ), environmental resources ( $X_2$ ), social resources ( $X_3$ ), institutional performance ( $Z$ ), and aspects of vulnerability of livestock businesses ( $Y$ ). These variables and indicators are described in Table 1 below:

**Table 1.** Research Variables and Indicators

Variable	Indicator	Notation
Economic resources ( $X_1$ )	formal education of farmers	$X_{1,1}$
	non-formal education for farmers	$X_{1,2}$
	the level of involvement of the family workforce	$X_{1,3}$
	family health status	$X_{1,4}$
	nutritional consumption status of the family	$X_{1,5}$
	comfort level of residence	$X_{1,6}$
	the opportunity to make use of free time for recreation	$X_{1,7}$
	the level of credibility of the farmer	$X_{1,8}$
Environmental resources ( $X_2$ )	level of air pollution	$X_{2,1}$
	level of soil pollution	$X_{2,2}$

Variable	Indicator	Notation
Social resources ( $X_3$ )	level of water pollution	$X_{2,3}$
	sound pollution level	$X_{2,4}$
	utilization of livestock manure waste for fertilizer	$X_{2,5}$
	utilization of agricultural waste for animal feed	$X_{2,6}$
	the role of farmers in community organizations	$X_{3,1}$
	cooperative relationships with other farmers	$X_{3,2}$
	relations with village officials	$X_{3,3}$
	liaison with animal health workers	$X_{3,4}$
	relationship with the livestock service	$X_{3,5}$
	relationship with animal feed companies	$X_{3,6}$
	relationship with field counselors	$X_{3,7}$
	relationship with financial institutions	$X_{3,8}$
relationship with IPS (Dairy Processing Industry)	$X_{3,9}$	
Institutional performance( $Z$ )	group facilities	$Z_{1,1}$
	achievement of group goals	$Z_{1,2}$
	group functions and tasks	$Z_{1,3}$
	group structure	$Z_{1,4}$
	group harmony	$Z_{1,5}$
	institutional form	$Z_{1,6}$
Vulnerability Aspects ( $Y$ )	season (forage feed availability)	$Y_{1,1}$
	security (theft of livestock)	$Y_{1,2}$
	livestock diseases and health	$Y_{1,3}$
	fluctuations in the selling price of fresh milk	$Y_{1,4}$
	government policy	$Y_{1,5}$
	group policy	$Y_{1,6}$
	morality of farmers in groups	$Y_{1,7}$

The relationship model between variables in Table 1 is explained in Figure 1 below:



**Fig 1.** Variable Relationship Model

Data were analyzed using the PLS (Partial Least Square) method using SmartPLS 2.0. The PLS method consists of two kinds of criteria, namely the outer model and the inner model. Test criteria on the outer model consist of test indicators (outer loading value), AVE value (Average Variance Extracted), Cronbach's Alpha value, and R Square value. The testing criteria in the inner model consist of the coefficient of determination, the value of t statistics, and the value of the parameter coefficient. Based on the description of the variables and indicators in Table 1 and the variable relationship model in Figure 1, the form of the mathematical equation is as follows:

Exogenous latent variable ( $X_1$ ) / reflective

$$\begin{array}{lll} X_{1.1} = (\lambda_1 \xi_1) + \delta_1 & X_{1.4} = (\lambda_4 \xi_1) + \delta_4 & X_{1.7} = (\lambda_7 \xi_1) + \delta_7 \\ X_{1.2} = (\lambda_2 \xi_1) + \delta_2 & X_{1.5} = (\lambda_5 \xi_1) + \delta_5 & X_{1.8} = (\lambda_8 \xi_1) + \delta_8 \\ X_{1.3} = (\lambda_3 \xi_1) + \delta_3 & X_{1.6} = (\lambda_6 \xi_1) + \delta_6 & \end{array}$$

Exogenous latent variable ( $X_2$ ) / reflective

$$\begin{array}{ll} X_{2.1} = (\lambda_9 \xi_2) + \delta_9 & X_{2.4} = (\lambda_{12} \xi_2) + \delta_{12} \\ X_{2.2} = (\lambda_{10} \xi_2) + \delta_{10} & X_{2.5} = (\lambda_{13} \xi_2) + \delta_{13} \\ X_{2.3} = (\lambda_{11} \xi_2) + \delta_{11} & X_{2.6} = (\lambda_{14} \xi_2) + \delta_{14} \end{array}$$

Exogenous latent variable ( $X_3$ ) / reflective

$$\begin{array}{lll} X_{3.1} = (\lambda_{15} \xi_3) + \delta_{15} & X_{3.4} = (\lambda_{18} \xi_3) + \delta_{18} & X_{3.7} = (\lambda_{21} \xi_3) + \delta_{21} \\ X_{3.2} = (\lambda_{16} \xi_3) + \delta_{16} & X_{3.5} = (\lambda_{19} \xi_3) + \delta_{19} & X_{3.8} = (\lambda_{22} \xi_3) + \delta_{22} \\ X_{3.3} = (\lambda_{17} \xi_3) + \delta_{17} & X_{3.6} = (\lambda_{20} \xi_3) + \delta_{20} & X_{3.9} = (\lambda_{23} \xi_3) + \delta_{23} \end{array}$$

Endogenous latent variable ( $Z$ ) / reflective

$$\begin{array}{ll} Z_{1.1} = (\lambda_{24} \eta_1) + \varepsilon_1 & Z_{1.4} = (\lambda_{27} \eta_1) + \varepsilon_4 \\ Z_{1.2} = (\lambda_{25} \eta_1) + \varepsilon_2 & Z_{1.5} = (\lambda_{28} \eta_1) + \varepsilon_5 \\ Z_{1.3} = (\lambda_{26} \eta_1) + \varepsilon_3 & Z_{1.6} = (\lambda_{29} \eta_1) + \varepsilon_6 \end{array}$$

Endogenous latent variable ( $Y$ ) / reflective

$$\begin{array}{lll} Y_{1.1} = (\lambda_{30} \eta_2) + \varepsilon_7 & Y_{1.4} = (\lambda_{33} \eta_2) + \varepsilon_{10} & Y_{1.1} = (\lambda_{36} \eta_2) + \varepsilon_{13} \\ Y_{1.2} = (\lambda_{31} \eta_2) + \varepsilon_8 & Y_{1.5} = (\lambda_{34} \eta_2) + \varepsilon_{11} & \\ Y_{1.3} = (\lambda_{32} \eta_2) + \varepsilon_9 & Y_{1.6} = (\lambda_{35} \eta_2) + \varepsilon_{12} & \end{array}$$

Exogenous latent variable ( $Z$ ) / formative

$$\eta_1 = ((\eta_1\gamma_1 + \eta_1\gamma_2 + \eta_1\gamma_3) + \varepsilon$$

Exogenous latent variable ( $Y$ ) / formative

$$\eta_2 = ((\eta_2\gamma_1 + \eta_2\gamma_2 + \eta_2\gamma_3 + \eta_2\beta_1) + \varepsilon$$

### 3 Result and Discussion

The indicator test results are in the form of outer loading values on the outer model system. The Indicators that are considered valid and meet the requirements are indicators that have an outer loading value > 0.500. Indicators with outer loading values < 0.500 are considered invalid and do not qualify, so they must be removed from the model. The indicator test results are described in Table 2 below:

**Table 2.** Indicator Test Results

Indicators	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	Z	Y	Result
X <sub>1.2</sub>	0.965					valid
X <sub>1.3</sub>	0.817					valid
X <sub>1.4</sub>	0.652					valid
X <sub>1.5</sub>	0.554					valid
X <sub>1.6</sub>	0.534					valid
X <sub>1.7</sub>	0.546					valid
X <sub>1.8</sub>	0.743					valid
X <sub>2.1</sub>		0.682				valid
X <sub>2.4</sub>		0.511				valid
X <sub>2.5</sub>		0.835				valid
X <sub>2.6</sub>		0.822				valid
X <sub>3.1</sub>			0.948			valid
X <sub>3.2</sub>			0.829			valid
X <sub>3.3</sub>			0.611			valid
X <sub>3.4</sub>			0.532			valid
X <sub>3.6</sub>			0.675			valid
X <sub>3.8</sub>			0.890			valid
X <sub>3.9</sub>			0.824			valid
Z <sub>1.1</sub>				0.553		valid
Z <sub>1.2</sub>				0.746		valid
Z <sub>1.3</sub>				0.866		valid
Z <sub>1.4</sub>				0.754		valid
Y <sub>1.4</sub>					0.785	valid
Y <sub>1.5</sub>					0.764	valid
Y <sub>1.6</sub>					0.852	valid
Y <sub>1.7</sub>					0.746	valid

Note: outer loading value after removing invalid indicator

Testing the outer model produces criteria that include the value of AVE (Average Variance Extracted), the value of CA (Cronbach's Alpha), and the value of R Square (R<sup>2</sup>). The outer model test results are described in Table 3 below:

**Table 3.** Outer Model Test Results

Variable	Notation	AVE	CA	R <sup>2</sup>
Economic resources	X <sub>1</sub>	0.834	0.851	
Environmental resources	X <sub>2</sub>	0.724	0.769	
Social resources	X <sub>3</sub>	0.938	0.865	
Institutional performance	Z	0.845	0.875	0.694
Vulnerability aspects	Y	0.688	0.856	0.439

The test model for the influence test or structural test consists of the coefficient of determination, the value of t statistics, and the value of the parameter coefficient. The inner model test results are described in Table 4 below:

**Table 4.** Inner Model Test Results

Testing	Value	Information
Coefficient of determination (R <sup>2</sup> )		
a. Institutional performance	0.694	
b. Vulnerability aspects	0.439	

Testing		Value	Information
t-statistic			
a.	$X_1 \rightarrow Z$	2.814	significant
b.	$X_2 \rightarrow Z$	1.612	not significant
c.	$X_3 \rightarrow Z$	3.726	significant
d.	$X_1 \rightarrow Y$	2.114	significant
e.	$X_2 \rightarrow Y$	1.564	not significant
f.	$X_3 \rightarrow Y$	2.417	significant
g.	$Z \rightarrow Y$	4.105	significant
Parameter coefficient			
a.	$X_1 \rightarrow Z$	2.814	positive effect
b.	$X_2 \rightarrow Z$	1.612	positive effect
c.	$X_3 \rightarrow Z$	3.726	positive effect
d.	$X_1 \rightarrow Y$	-0.232	positive effect
e.	$X_2 \rightarrow Y$	-0.086	positive effect
f.	$X_3 \rightarrow Y$	-0.313	positive effect
g.	$Z \rightarrow Y$	-0.301	positive effect

t table: 1.653

The institutional performance of dairy farmers is influenced by economic, environmental and social resources by 39.4%. This shows the importance of resources in building an institution, so that it shows the role of the institution in shaping the farmer's identity. In line with the opinion of Sudardjat and Pambudy[8], which states that one of the pillars in animal husbandry development is the institution and skills of farmers. Because, the role of institutions in shaping farmers' identities is largely ignored[9].

### 3.1 The Effect of Economic Resources on Institutional Performance

Economic resources have a positive and significant effect on institutional performance. This shows that the carrying capacity of economic resources plays an important role in improving institutional performance. Non-formal education is important to improve institutional performance. The form of non formal education in KUB (Joint Business Group) Tirtasari Kresna Gemilang is training in the maintenance of dairy cattle, training in formulation of animal feed, and training in processing fresh milk products. The level of involvement of the family workforce supports good institutional performance. Family members play a role in the dairy farming business. The role is as a grass hunter, milking man, and as a cage cleaner. The family health status also supports institutional performance. When family members are healthy, the role of the dairy farming business is in accordance with their duties and responsibilities. The nutritional consumption status of the family supports good institutional performance. Nutritious food contributes to the health of family members. Nutritious food is also an indicator of the welfare of dairy farmers. The level of comfort of a residential home is one of the supporters of institutional performance. The opportunity to use free time for recreation can reduce the stress of dairy farmers, so it also supports institutional performance. The level of credibility of the farmer determines institutional performance. The more credible farmers, the better the institutional performance.

### **3.2 The Effect of Social Resources on Institutional Performance**

Social resources have a positive and significant effect on institutional performance. This shows that the carrying capacity of social resources plays an important role in improving institutional performance. According to Haryadi in Solikin, et al[10] that formal group participation can be decisive in the sustainability of livestock business. The role of farmers in community organizations supports institutional performance. Institutions are formed from relationships among the community, including relations between dairy farmers. Relationships with village officials are good, making institutional performance stronger, due to the carrying capacity of the local government. Relations with animal health workers also play a role in institutional performance. Institutional dairy cows Kirt Tirtasari Kresna Gemilang has three veterinarians specializing in handling dairy cows. Relationships with animal feed companies can strengthen farmer institutions. KUB Tirtasari Kresna Gemilang in addition to making its own feed also gets supplies from several feed companies, including raw materials. Relationships with financial companies are related to savings and loans for livestock business capital. This can support the sustainability of the dairy farming business. Relationships with companies / Milk Processing Industries (IPS) can also strengthen the institutional performance of dairy farmers. KUB Tirtasari Kresna Gemilang has collaborated with various milk processing companies, including PT Milkindo and and PT Indolakto.

### **3.3 The Effect of Institutional Performance on Vulnerability Aspects**

Institutional performance has a negative and significant effect on the vulnerability aspect of dairy cattle business. This shows that the higher the institutional performance of dairy farmers, the lower the vulnerability aspects of the dairy farming business. Amam and Harsita[7] state that the vulnerability aspect is a hazard condition (both natural hazard and artificial hazard) that can pose a risk of loss to livestock business. Vulnerability aspects of dairy cattle business in KUB Tirtasari Kresna Gemilang consist of fluctuations in the selling price of fresh milk, government policies, group policies, and the morality of farmers in the group. The institutional role of KUB Tirtasari Kresna Gemilang to overcome the fluctuations in the selling price of fresh milk is by establishing a partnership in general trade patterns with companies / Milk Processing Industries (IPS). General trade pattern partnership is the implementation of partnerships carried out in the form of marketing cooperation, the provision of business locations, or the receipt of supplies from micro, small and / or medium-sized businesses by openly large businesses[4].

The institutional role of KUB Tirtasari Kresna Gemilang on government policy is to synergize with the local government of Malang Regency regarding the development of dairy cattle business, empowerment of farmers, and institutional strengthening. The efforts to develop livestock business, farmer empowerment, and institutional strengthening are also carried out in collaboration with Jember University. KUB Tirtasari Kresna Gemilang became one of the groups built by Jember University through the Department of Animal Husbandry, Faculty of Agriculture. The institutional role of KUB Tirtasari Kresna Gemilang on group policy is to continue to work for the welfare of its members, provide excellent service, and improve the economy of the community. Solikin et al [11] states that farmers have a low entrepreneurial spirit because motivation to develop business scale is constrained by small financial capital, limited access to capital, limited networking, and too traditional to run a business. The institutional role of KUB Tirtasari Kresna Gemilang to breeder's morality within the group is to pay attention to its members and urge to cooperate with each other in a team, so

that the synergy between breeders and institutions runs according to their duties and responsibilities.

### **3.4 The Effect of Environmental Resources on Vulnerability Aspects**

Environmental resources have a negative and significant effect on aspects of vulnerability. This means that the higher the environmental resources of dairy farmers, the lower the vulnerability aspect of dairy farming businesses. Environmental resources consist of air pollution, sound pollution, utilization of livestock waste for fertilizer, and utilization of agricultural waste for animal feed. Air pollution and sound pollution are inseparable from livestock business. This is closely related to aspects of the vulnerability of livestock businesses, so that environmental quality can affect the aspects of vulnerability of livestock businesses. Utilization of waste for plant fertilizer and utilization of agricultural waste for animal feed is a form of integration of plants with livestock. Bamualim et al. [12] states that one of the solutions to providing quality animal feed is through the use of agricultural residues as alternative feed. This option is an option to anticipate the availability of forage during the dry season and the effect of land conversion.

### **3.5 The Effect of Social Resources on Vulnerability Aspects**

Social resources have a negative and significant effect on the aspect of vulnerability. This means that the higher the social resources of dairy farmers, the lower the vulnerability aspect of dairy farming businesses. Sharp and Smith[13]; Solikin, et al[10] states that there is a correlation between social capital in agriculture and non-agriculture sectors so that development occurs. The social relations of farmers with the community, fellow breeders, village governments, animal health workers, animal feed companies, financial institutions, and companies / Milk Processing Industry (IPS) can reduce the impact of the vulnerability aspects of dairy cattle business.

## **4 Conclusion**

Institutional performance is influenced by economic, environmental and social resources by 39.4%, while the aspects of vulnerability of livestock business are influenced by institutional performance and economic, environmental and social resources by 23.9%. The strength of resources supported by institutional performance can reduce aspects of the vulnerability of livestock businesses.

## **References**

- [1] A. Amam and S. Soetriono, "Evaluasi Performa Kelembagaan Peternak Sapi Perah Berdasarkan Aspek Risiko Bisnis dan Pengembangan Usaha," 2019.
- [2] A. Amam, Z. Fanani, B. Hartono, and B. A. Nugroho, "Model of Resources Development in Partnership System of Broiler Farming Business," *J. Ilmu Ternak dan Vet.*, vol. 24, no. 3, 2019.
- [3] A. Amam, M. W. Jadmiko, P. A. Harsita, and M. S. Poerwoko, "Model Pengembangan Usaha Ternak Sapi Perah Berdasarkan Faktor Aksesibilitas Sumber Daya," *J. Sain Peternak. Indones.*, vol. 14, no. 1, pp. 61–69, 2019.
- [4] A. Amam, Z. Fanani, B. Hartono, and B. A. Nugroho, "Usaha Ternak Ayam Pedaging



- Sistem Kemitraan Pola Dagang Umum: Pemetaan Sumber Daya dan Model Pengembangan,” *Sains Peternak. J. Penelit. Ilmu Peternak.*, vol. 17, no. 2, pp. 5–11.
- [5] A. Amam and P. A. Harsita, “Pengembangan Usaha Ternak Sapi Perah: Evaluasi Konteks Kerentanan Dan Dinamika Kelompok,” *J. Ilm. Ilmu-Ilmu Peternak.*, vol. 22, no. 1, pp. 23–34, 2019.
- [6] A. Amam, M. W. Jadmiko, P. A. Harsita, N. Widodo, and M. S. Poerwoko, “SUMBER DAYA INTERNAL PETERNAK SAPI PERAH DAN PENGARUHNYA TERHADAP DINAMIKA KELOMPOK DAN KONTEKS KERENTANAN,” *J. Ilm. Peternak. TERPADU*, vol. 7, no. 1, pp. 192–200, 2019.
- [7] A. Amam and P. A. Harsita, “Aspek Kerentanan Usaha Ternak Sapi Perah di Kabupaten Malang,” *AGRIMOR*, vol. 4, no. 2, pp. 26–28, 2019.
- [8] S. Sudardjat and R. Pambudy, *Menjelang dua abad sejarah peternakan dan kesehatan hewan di Indonesia: peduli peternak rakyat*. Yayasan Agrindo Mandiri, 2003.
- [9] P. Stenholm and U. Hytti, “In search of legitimacy under institutional pressures: A case study of producer and entrepreneur farmer identities,” *J. Rural Stud.*, vol. 35, pp. 133–142, 2014.
- [10] N. Solikin, B. Hartono, Z. Fanani, and M. N. Ihsan, “The Contribution of Social Capital to the Income and Development of Beef Cattle Farmers,” in *IOP Conference Series: Earth and Environmental Science*, 2019, vol. 372, no. 1, p. 12053.
- [11] N. Solikin, “Entrepreneurship Kelompok Tani Ternak Studi Kasus Di Kabupaten Kediri,” *J. Pendidik. Ekon.*, vol. 1, no. 02, 2016.
- [12] A. M. Bamualim, F. Madarisa, Y. Pendra, E. Mawardi, and A. Asmak, “Kajian Inovasi Integrasi Tanaman–Ternak melalui Pemanfaatan Hasil Ikutan Tanaman Sawit untuk Meningkatkan Produksi Sapi Lokal Sumatera Barat,” *J. Peternak. Indones. (Indonesian J. Anim. Sci.)*, vol. 17, no. 2, pp. 83–93, 2015.
- [13] J. S. Sharp and M. B. Smith, “Social capital and farming at the rural–urban interface: the importance of nonfarmer and farmer relations,” *Agric. Syst.*, vol. 76, no. 3, pp. 913–927, 2003.