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Risk Production Analysis of Small-Scale Beef Cattle Farmers in the Special Region of Yogyakarta, Indonesia

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Abstract: *Various problems related to the production of beef cattle faced became an essential issue in Indonesia. The purpose of this study was to analyze and compare the risk of small-scale beef cattle farmers production, to know the behavior of beef cattle farmers on the production risk, and also to know the effect of input use to production risk in the Special Region of Yogyakarta, Indonesia, between the farmers of fattening beef cattle self-ownership and partnership systems. A survey was conducted in Sleman, Gunungkidul, Bantul, and Kulonprogo Regencies, using purposive sampling method. The respondents are 240 beef cattle farmers who were interviewed using structured questionnaires, divided into 120 self-ownership and 120 partnership farmers. The technique used is the analysis of coefficient of variation (CV), calculation of aversion value on risk or amount of K(s), and multiple linear regression analysis with a heteroscedastic method.*

The results show that the production risk of fattening beef cattle farmers of self-ownership system is higher than partnership system. Most self-ownership and partnership farmers are similar since they prefer to avoid the risk (risk aversion). Factors that significantly affect and increase the production risk (risk-increasing factors) are forage variable and the frequency of extension in self-ownership system, concentrate variables on partnership system, while factors that significantly affect the production risk of beef cattle (risk-reducing factors) are dummy types of cattle, dummy livestock groups on the self-ownership system, as well as forage and labor variables on partnership system.

Keywords: *beef fattening, partnership, risk behavior, self-ownership, yogyakarta*

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I. Introduction

For long years, Indonesia faces a very crucial problem related to the fulfilment of one vital food source which is beef. The availability (production) and need (consumption) of meat have deficit due to the national beef self-sufficiency program which has not reached the target expected yet. Therefore, the fulfilment of the national beef requirement is still highly dependent on imported beef. According to FAO (2018), the rapid growth in livestock production and trade does bring not only opportunities but also risks. The risks include concerns over food and nutrition security, livelihoods and equity, animal health, welfare and the environment. The livestock sector in Indonesia also faces this condition.

According to the data from the Ministry of Agriculture (2016[a]), there are three islands and 17 regencies in Indonesia which are the centre of beef cattle breeding as the priority of strengthening the first/ local breeding beef cattle in 2016. One of the 17 regencies is located in the Special Region of Yogyakarta (DIY), namely Gunungkidul Regency, which is determined to be a potential source of locally grown Ongole crossbreed (PO). The Special Region of Yogyakarta is one of the provinces in Indonesia that has the dynamic and fluctuating number of beef cattle from year to year and spread in 5 regency/ city with diverse populations. Nevertheless, until the end of 2016, there was still a deficit in the supply of beef in Yogyakarta as much as 16.284 tons, which has not been able to be supplied from the availability of local cattle from the scope of beef cattle farming in the Special Region of Yogyakarta (BKPP, 2017).

The fulfilment of the availability of live cattle or beef in Indonesia is mostly (97%) still relying on the supply of small-scale beef cattle farmers with a relatively small scale of livestock ownership. Ilham et al. (2009) mention that small-scale farmers generally breed local cattle with a small amount of ownership and far from an

optimal business scale. The presence of some small-scale farmers in Indonesia is because of the limited capital, breeding the beef cattle with a system of partnership that is producing the livestock owned by others, usually brothers or close neighbors, with a profit-sharing scheme.

Constraints and risks that are often faced by beef cattle farmers (both self-ownership and partnership systems) in Indonesia according to Baba et al. (2013) include: 1) Beef cattle business is as a sideline business/ saving; 2) The time allocation for beef cattle farmers is only 2-3 hours per day; 3) The livestock breeding ability is insufficient, the scale of beef cattle business is only around 2 to 3 cattle; and 4) Limited access on feed technology of farmers, so that the majority of the farmers look for their forage by taking it from private land or empty land.

Therefore, the aims of this study are to 1) compare the risk of production in beef cattle farmers between self-ownership and partnership systems in the Special Region of Yogyakarta; 2) analyse the farmer's behavior against production risk; and 3) analyse the factors affecting the production and risk production of beef cattle farmers.

II. Methodology

Study area and sampling technique

The study was conducted in 4 regencies of Special Region of Yogyakarta, namely Sleman, Gunungkidul, Bantul, and Kulonprogo. The four locations were chosen by purposive sampling because it is the region with the largest beef cattle population in the Special Region of Yogyakarta. The total research respondents were 240 fattening beef cattle farmers in four study sites, 60 people were selected from each regency, consisting of 30 self-ownership farmers and 30 partnership farmers using quota sampling technique (Widiati, 2003).

This quota sampling technique was chosen because researchers did not consider the population as a very different sample frame and the amount regarding numbers, especially the self-ownership system farmers. In contrast, the number of beef cattle farmers in the four research sites is not as much as the self-ownership system farmers and their locations are scattered in many villages in each district.

Data analysis

The risk analysis of beef cattle business includes risk analysis of the small-scale beef cattle farmers among the system of self-ownership and partnership systems. The ratio of production risk between the self-ownership and partnership systems, it was analysed by using the coefficient of variation (CV). The coefficient of variation (CV) is a measure of the relative risk obtained by dividing the standard deviation by the expected value (Calkin and DiPietre, 1983; Pappas and Hirschey, 1995; Anderson et al., 1977). Mathematically, the risks are formulated as follows:

$$CV = {}^{\delta}/_{\bar{X}}$$

$$\delta = \sqrt{\frac{\sum x^2}{n}}$$

$$n = x - \bar{X}$$

where:

CV = coefficient of variation;
δ = standard deviationof production;
$\bar{X}$ = the mean of production;
n = the number of sample

The behavior of farmers against the risk, a method is used following Moscardy and de Janvry (1977) by looking for the input value which has a significant effect (value B on Unstandardized Coefficient) on production, using SPSS software version 24. According to Moscardy and de Janvry (1977), the parameter of aversion values on risk (risk aversion) with K (s) notation can be used to classify the farmers into 3 groups, those are: risk preferring (low risk: $0 < K(s) < 0.4$); risk neutral (intermediate risk: $0.4 \leq K(s) \leq 1.2$); and risk aversion (high risk: $1.2 < K(s) < 2$). The parameter value of K(s) is obtained from the following equation:

$$K(s) = \frac{1}{\theta}\left(1 - \frac{Pxi.Xi}{Py.fi.\mu y}\right)$$

where:
θ = the coefficient of variation from the beef cattle production ($\theta=\delta y/\mu y$);
δy = standard deviation of production;
Pxi = input price i (the most significant input prices);
Xi = number of i-th input (number of most significant input);
Py = beef cattle production price (kg);
fi = the elasticity of input production i (the elasticity of the most significant input);
μy = the average production of beef cattle (kg);
K(s) = the value of risk aversion parameter

Empirical modelling of production and risk production

The amount of effect of input use on the risk of beef cattle production of self-ownership and partnership systems is analysed by using multiple linear regression with the heteroscedastic method. The heteroscedastic model used is the multiplicative heteroscedasticity model by maximising the likelihood function (Just and Pope, 1979; Roumasset et al., 1976; Greene, 2003). The regression model for the effect of input use on production and production risk, both beef cattle business in self-ownership and partnership systems written as follows:

$$\ln Y = \ln \alpha_0 + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + \alpha_5 \ln X_5 + \alpha_6 \ln X_6 + \alpha_7 \ln X_7 + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \varepsilon_1$$

$$(\varepsilon_1^2) = \ln \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \varepsilon_2$$

where:
ln Y = The production of beef cattle business of self-ownership/ partnership systems (kg)
ε_1^2 = The production risk of self-ownership/ partnership systems (*absolute residual*)
X_1 = Numbers of weaned cow-calf (Animal Unit=AU/period)
X_2 = Amount of forage feed (kg/period)
X_3 = Amount of concentrate feed (kg/period)
X_4 = Numbers of livestock medicines (gr/period)
X_5 = Amount of supplement feed (gr/period)
X_6 = Numbers of labor (man-days/period)
X_7 = Numbers of extension frequency (times/period)
D_1 = Dummy of farmers education, if education > 9 years =1, if education 0-9 years = 0
D_2 = Dummy of cattle type, Non-Local Cattle = 1, Local Cattle (PO) = 0
D_3 = Dummy of the membership of livestock group, if joined = 1, if not joined = 0
$\alpha_0; \beta_0$ = *Intercept*
$\alpha_i; \beta_i$ = The coefficient of parameter estimator, where i = 1,2,.....,7
δ = The regression coefficient of dummy variable
$\varepsilon_1; \varepsilon_2$ = *error term* (residual)

Before performing the multiple regression analysis, some standard assumption tests were performed: normality (with normally distributed error results), homogeneity of variance/ heteroscedasticity and multicollinearity (with homoscedasticity and non-multicollinearity). The statistical analysis of the regression model consists of three kinds of test that are the coefficient of determination (R^2) to get the value of the accuracy of the model used, F test, and individual test (t-test).

III. Result and Discussion

Production risk and the farmer's risk behavior

The estimation result of production function obtained that the most significant input at the level of α = 1% which contribute the most to the production of self-ownership system is the amount of forage feed with B Unstandardized Coefficient value is 0.403. Meanwhile, inputs that have the most significant effect on partnership system is the amount of forage feed with a value of 0.496, as presented in Table no 1.

Table no 1 : Production function estimation of self-ownership and partnership systems

Variables	Unstandardized Coefficient		Standardized Coefficient	T	Sig.
	B	Std. Error	Beta		
Self-ownership system					
Constant (C)	-0.909	0.922		-0.986	0.326
ln Cow-Calf	0.206[b]	0.090	0.143	2.295	0.024
ln Forage Feed	0.403[a]	0.115	0.201	3.511	0.001
ln Concentrate Feed	0.371[a]	0.049	0.449	7.520	0.000
ln Medicine	0.054	0.036	0.080	1.471	0.144
ln Supplement Feed	0.115[a]	0.037	0.181	3.085	0.003
ln Labor	0.007	0.051	0.005	0.138	0.891
Partnership system					
Constant (C)	-1.345	0.993		-1.345	0.178
ln Cow-Calf	0.492[a]	0.115	0.302	4.283	0.000
ln Forage Feed	0.496[a]	0.122	0.333	4.071	0.000
ln Concentrate Feed	0.262[a]	0.061	0.288	4.269	0.000
ln Medicine	-0.077[b]	0.035	-0.103	-2.164	0.033
ln Supplement Feed	0.109[b]	0.045	0.141	2.398	0.018
ln Labor	0.141[c]	0.075	0.075	1.876	0.063
Remarks: a, b, and c significant at α = 1%, α = 5%, and α = 10%					

The coefficient value of small production variation shows that the variability of low average production value. It illustrates that the production risks encountered to obtain the result is small, and vice versa. The production risks comparison between self-ownership and partnership systems and the variable required to determine the value of K(s) can be seen in Table 2. Based on the analysis result, it can be examined that Table no 2 shows that the production risk of self-ownership system is higher than partnership system. It indicates that there is a higher production variation in the self-ownership system than partnership system.

Table no 2 : The variable of the calculation of aversion behavioral degree on the risk of self-ownership and partnership systems of beef cattle farmers

Variables	Systems	
	Self-Ownership (n=120)	Partnership (n=120)
Coefficient (B Unstandard. Coeff.) (fi)	0.403	0.496
The mean of production (μy) (kg)	481.4	394
Standard Deviation of Production (δy)	249.93	199.95
A Coefficient of Variation (θ)	0.5192	0.5075
CV (%)	51.92	50.75

Based on Table no 2, the average production of self-ownership system is higher than the average production of partnership system and is significantly different at α = 1%. Other variables that also determine the aversion parameter value of the farmers on the risk are the number of forage feed (Xi), forage feed price (Pxi), and beef cattle price per kg (Py) in each respondent. The calculation results of aversion parameter of farmers in facing the risk or value of K(s) of beef cattle farmers are presented in Table no 3.

Table no 3: The distribution of self-ownership and partnership beef cattle farmers systems based on risk types

Risk Types	Self-Ownership System			Partnership System		
	Amount (person)	%	Average Value of K(s)	Amount (person)	%	Average Value of K(s)
Risk preferring ($0 < K(s) < 0.4$)	18	15	0.24	9	7.5	0.22
Risk-neutral ($0.4 \leq K(s) \leq 1.2$)	46	38.33	0.71	49	40.83	0.72
Risk aversion ($1.2 < K(s) < 2$)	56	46.67	1.23	62	51.67	1.25
Total	120	100		120	100	

In Table no 3, it can be seen that the whole aversion behavior level on the preferring risk types shows that the self-ownership system is bigger than the partnership system which is respectively by 15% and 7.5%. The risk-neutral group of self-ownership system is lower than the risk-neutral group of partnership system with 38.33% and

40.83% respectively. The risk aversion group of self-ownership system is lower than the risk aversion group of partnership system which is 46.67% compared to 51.67%.

The research results on the behavior of self-ownership and partnership systems farmers in facing the production risks which mostly belongs to the risk aversion group are in line with the research conducted by Mosnier et al. (2009) that the average beef cattle farmers behave in a way to reject the production risk (risk aversion). Both self-ownership and partnership systems of beef cattle farmers mostly act in rejecting to the risk.

Beef cattle farmers with risk-taking behavior (risk preferring/ risk taker) tend to dare to take production risks for the use of forage feed because forage feed are considered as the primary input (supplies), which is critical to the success of beef cattle business. But for farmers with neutral behavior and reject the risk of not daring to take the risk of the use of forage feed, due to the time and labour limitations in the search for forage feed, and lack of capital for some farmers to buy forage feed.

Factors affecting the production risk of self-ownership and partnership systems

The production risk of beef cattle business on the use of production factors, it is analysed by using Cobb Douglas production function model according to Just and Pope (1979). The model shows the effect of production factors on the production of self-ownership and partnership beef cattle business. The analysis result of the estimation of production function and risk of self-ownership system using Non-Linear Least Square method through EViews 9 application can be seen in Table no 4.

Table no 4 : Factors affecting the production and production risk of self-ownership beef cattle system in the Special Region of Yogyakarta using OLS method (n = 120)

Variables	Production Function		Risk Production Function	
	Coefficient	**Prob > | t |**	**Coefficient**	**Prob > | t |**
Constant (C)	1.78[c]	0.0692	-9.933[c]	0.0836
ln Weaned Cow-Calf (X_1)	0.46[a]	0.0000	0.159	0.77
ln Forage Feed (X_2)	0.203[c]	0.0660	1.074[c]	0.0970
ln Concentrate Feed (X_3)	0.201[a]	0.0003	0.146	0.65
ln Livestock Medicine (X_4)	0.0575[c]	0.0837	-0.133	0.49
ln Supplement Feed (X_5)	0.0933[a]	0.0071	-0.206	0.30
ln Number of Labour (X_6)	0.00873	0.85	-0.302	0.29
ln Extension Frequency (X_7)	-0.0250	0.57	0.646[b]	0.0133
Dummy of Education Level	0.00363	0.91	0.256	0.20
Dummy of Cattle Type	0.27[a]	0.0000	-0.685[b]	0.0226
Dummy Membership Group	0.0428	0.34	-0.498[c]	0.0953
R-squared	0.89		0.15	
F-statistic	91.566		1.922	
Remarks: a, b, and c significant atα=1%, α = 5%, and α = 10%				

Based on the analysis results presented in Table no 4, it is known that the coefficient of determination (R^2) of the production function and risk function are 0.89 and 0.15 respectively. It indicates that 89% of production variation and 15% of production risk variation of self-ownership beef cattle business can be explained by the change of independent variables in the model or 89% of independent variables simultaneously affect the production, and the remaining 11% is affected by anything else outside the model. The independent variables of 15% simultaneously affect the production risk, and the remaining 85% is affected by anything else outside the model. The result of F test shows that the value of F count of production function is 91.566 and the risk function is 1.922 which is more significant than F table (Probability = 1%) of 1.63. It means that the independent variable simultaneously and significantly affects the production and risk of production. To know the partnership system factors that influence the production and risk of production is presented in Table no 5.

Table no 5 : Factors affecting the production and production risk of partnership beef cattle system in the Special Region of Yogyakarta using OLS method (n = 120)

Variables	Production Function		Risk Production Function	
	Coefficient	**Prob > | t |**	**Coefficient**	**Prob > | t |**
Constant (C)	-0.75	0.4436	6.600	0.19
ln Weaned Cow-Calf (X_1)	0.66[a]	0.0000	-0.260	0.68
ln Forage Feed (X_2)	0.57[a]	0.0000	-1.403[b]	0.0263
ln Concentrate Feed (X_3)	0.061	0.45	1.027[b]	0.0168
ln Livestock Medicine (X_4)	-0.068[b]	0.0494	0.247	0.17
ln Supplement Feed (X_5)	0.063	0.17	-0.008	0.97

ln Number of Labour (X_6)	0.149[b]	0.0413	-0.738[c]	0.0512
ln Extension Frequency (X_7)	-0.012	0.83	-0.060	0.84
Dummy of Education Level	-0.037	0.36	0.083	0.69
Dummy of Cattle Type	0.21[a]	0.0010	-0.543	0.10
Dummy Membership Group	0.013	0.81	-0.115	0.71
R-squared	0.84		0.11	
F-statistic	59.388		1.636	
Remarks: a, b, and c significant at α = 1%, α = 5%, and α = 10%				

Based on the analysis results presented in Table no 5, it is known that the coefficient of determination (R^2) of the production function and production risk function are 0.84 and 0.11, respectively. It indicates that 84% of the variation in production and 11% of a difference in the risk of beef cattle production can be explained by the variety of independent variables in the model. In other words, 84% of independent variables simultaneously affect the production, and the remaining 16% is affected by anything else outside the model, and 11% of independent variables simultaneously affect production risk, and the remaining 89% is affected by anything else outside the model. The result of F test shows that the value of F count of the production function is 59.388 and the risk function is 1.636 which is more significant than F table (Probability = 1%) of 1.63. It means that the independent variable simultaneously and significantly affects the production and the risk of beef production.

The variable of calf number has a positive and signified coefficient value which significantly affect the production of beef cattle both from the self-ownership and partnership system. The addition of 1 AU calf will increase the production of self-ownership and partnership system by 46% and 66% respectively ($p<0.01$). It also increases the variation in the risk of a self-ownership beef cattle production system but reduces the risk of partnership system, although it is not significantly. The coefficient value of -0.260 indicates that there is an opposite relationship which means that the addition of calf will decrease the risk of partnership beef cattle system, but the small change effect that is 0.26% cause the calf not significantly to affect the variation of a beef cattle production system.

The coefficient value of forage feed variables both self-ownership and partnership system of beef cattle is positive significantly affect the production. The feed addition of 1% will increase the production of self-ownership and partnership system of beef cattle production as much as 20.3% ($p>0.05$) and 57% ($p<0.01$), respectively. However, the addition also increases the variety of self-ownership system production results. On the contrary, it reduces the risk variation of partnership system production by 1.403% ($p<0.05$). Most cattle farmers do not consider the cattle weight they maintain as the basis for daily forage feeding. According to Ministry of Agriculture (2016[b]) standards, forage feed should be given between 10-12% of the beef cattle body weight. It is possible because most of the small-scale farmers never do continuous cattle weighing; therefore the feeding is done without clear number and standard.

The use of concentrate feed a significant effect and positive coefficient on production and risk of beef cattle production both self-ownership and partnership systems. The addition of 1% concentrate feed will increase the production of self-ownership and partnership beef cattle system respectively by 20.1% ($p<0.01$) and 6.1%. However, it increases the production risk by 0.146% and 1.027% ($p<0.05$) respectively. Although the use of concentrate feed is very necessary, but the condition of the field maintenance shows that the application of the quantity of concentrate feed by most of the small-scale farmers in the Special Region of Yogyakarta does not consider the cattle weight according to Ministry of Agriculture (2016[b]) standard, which regulates that the amount of concentrate feed 1-2% of the beef cattle weight. Therefore, the unmeasured concentrate feeding may increase the risk of beef cattle production.

The variable of medicine has a positive and significant effect in increasing the production of self-ownership beef cattle system. Meanwhile, in the partnership system, the addition of medicine lowered the production and increased the risk. The use of unmanageable and uncontrolled dosage of medicine, especially on the partnership system, results in an increased risk of production in livestock maintained.

The use of supplements feed a significant and positive effect on the production of self-ownership beef cattle system, but it does not significantly affect the production and risk of partnership system. Most self-ownership farmers in the Special Region of Yogyakarta have sufficient capital in breeding the beef cattle. Therefore, there is an allocation of funds to purchase the supplements/ additional feed, compared to the production of partnership farmers.

Labour has no significant effect on the production and production risk of self-ownership beef cattle system, but it is influential in partnership system. The addition of 1% of labour will increase the production of partnership beef cattle system by 14.9% ($p<0.05$) and reduce the production risk by 0.738% ($p>0.05$). It is because the time

allocation spent by the partnership system in raising the livestock is more than the self-ownership system farmers, most of whom have major work in other fields.

Extension activities and dummy variables of education level do not affect the production of self-ownership and partnership beef cattle system. However, the frequency of extension increases the production risk of self-ownership system by 0.646% ($p<0.05$). The field extension agent is not yet intensively in assisting and providing services to the farmers. According to BPS (2017), 84.28% of beef cattle farmers in the Special Region of Yogyakarta have never received any extension guidance, and only 15.72% of the farmers have ever participated in extension activities. Most of the beef cattle farmers in the Special Region of Yogyakarta are also poorly educated. The level of education of farmers should be able to give a positive effect on the behavior to the risk by reducing the reluctance/ rejection of the risk in beef cattle livestock business (Bishu et al., 2016). In order to increase the adoption of the technology and production of small-scale farmers, it is necessary to increase the level of education of the farmers, farmers access to off-farm income, providing access to animal health training (Musaba, 2010), as well as improving the access to extension services provided by extension agent (Adesehinwa et al., 2004).

Dummy variable of the cattle type has a significant and positive effect on beef cattle production of both self-ownership and partnership systems. It also has an impact in decreasing the risk, even though it is less significant in partnership system. The results of this study indicate that for the fattening business, raising crossbreeding (Limousine/ Simmental) cattle is better than local cattle (PO). The coefficient value of dummy variable of livestock membership both self-ownership and partnership beef cattle is positive, but it has no significant effect on the production although it can reduce the production risk of self-ownership system. It indicates that the participation of beef cattle farmers in livestock groups is no better than those who do not belong to livestock groups. According to BPS (2017), only 18.22% of beef cattle farmers in the Special Region of Yogyakarta are incorporated in livestock groups, while the remaining 81.78% are not included.

IV. Conclusion

1. The production risk faced by beef cattle business of self-ownership system is higher as compared to the beef cattle business of partnership system.
2. Most of the self-ownership and partnership beef cattle farmers in the Special Region of Yogyakarta share the similar risk-aversion behavior.
3. Factors that have a significant effect on production risks (risk-increasing factors) are forage feed and extension frequency in self-ownership system, as well as concentrate variables in partnership system. Meanwhile, the factors that reduce the risk of beef cattle production (risk-reducing factors) include dummy cattle type, dummy livestock groups on the self-ownership system as well as forage and labour variables on the partnership system.

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