Production Fluctuation and Risk Preference of Potato Farming in the Bromo Plateau, Indonesia

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Abstract

Potato farming in Indonesia is carried out in the highlands one of them is the Bromo plateau/highland. Highland farming has a high risk of production due to sloping land topography and steep slopes. In addition, low managerial ability in responding to sources of production risk result in the input allocation produce non optimal production so that the input used is less efficient. This research aimed to identify production fluctuation and farmers' risk preferences, measure the level of technical efficiency, and determine the effect of risk preference, land conservation technology and socioeconomic factors on technical efficiency. The respondents in this study were 83 farmers. Just and Pope risk function with a utility function approach to find farmers' risk preferences, technical efficiency measurements using the stochastic Frontier Cobb Douglas which processed using the Frontier 4.1 program, while to find out the influence of the factors that influence efficiency used Tobit regression. The analysis showed that the respondents behaved risk takers amounted to 62,65%. Respondent has not yet reached technical efficiency with an average level of technical efficiency of 0.774. Education, frequency of counseling and training, the application of terrace systems have a significant positive effect on technical efficiency while land slope has a significant negative effect. Risk preference isn't affected on the technical efficiency and show positive sign. Therefore, need the existence of policies that focus on the factors that cause technical inefficiencies so that farmers' managerial capacity is increased.

Keywords: potato, risk preferences, technical efficiency, Bromo highland, Indonesia

Introduction

Potato is the important commodity of highland vegetable farmers. Potato prices are more stable than other highland vegetable crops. Potato farming has good prospects because its marketing is quite broad, namely domestic and foreign markets. The demand for potatoes continues to increase along with the increase in people's income and the development of the potato-based food processing industry. The increase in demand for potatoes must be balanced with an increase in production. The development of potato production in Indonesia fluctuates. Production fluctuations occur due to dependence on weather, market prices, and government policy support. Data shows that in 2012 production reached 1,094,000 tons, in 2014 it was 1,435,000 tons, but in 2016 it decreased to 1,213,000 tons (BPS, 2017).

Potatoes are a horticultural commodity that has an opportunity to be developed. Potatoes are planted in more than 150 countries in the world including Indonesia. Food and Agriculture Organization data in 2017 shows that Indonesian potato production is still relatively low and only contributes 2.2% of world production and ranks 43rd in the world's potato producers. Indonesia has several potato-producing regions among others Java, Sumatra, and Sulawesi. The last five years the production of potatoes in Indonesia showed rising trend, in 2018 reached 1.284.762 tons with a productivity level of 18.71 tons/hectare. As production increases the consumption level also shows an increase, in 2018 the level of potato consumption is 2.2 kg/capita. The increase in potato consumption was triggered by the development of the potato-based food processing industry and the food diversification program. The increase in consumption must be supported by an increase in production so that dependence on imports will decline.

Potatoes in Indonesia are highland vegetable crops because potatoes in Indonesia are generally grown in the highlands. The Highland/plateau that suitable for planting potatoes is at altitudes above 1000 to 3000 meters after sea level (masl). Indonesia has many plateaus which are the center of potato farming, one of them is the Bromo plateau. However, the plateau/highland has a steep slope causing erosion that does not benefit for farmers and crop failure. The recommended slope of land for potato farming is less than 30% (Henny, 2012). A slope of more than 30% has a sizeable barrier that can reduce production and profits or require substantial resources to sustain production. Farmers have no other choice, so they use the land continuously. Highland potato farming is generally carried out throughout the year without crop rotation. Planting continuously in the same land in addition to causing erosion also increases pest attack so that production decreases. Coupled with climate change causes more diverse types of disease pests so that the use of pesticides is not measurable.

Upland/ highland farmers with steep slope are faced with conditions that cannot be controlled. Natural disasters, landslides and degradation of soil quality are factors that can disrupt the process of agricultural production. Liu et al. (2019) stated that the topography of the land effect on the behavior of farmers in increasing production. Agricultural technology to overcome topographic conditions in highlands is the application of land conservation technologies, such as the use of cover crops, the use of mulch, terracing or crop rotation (Hong, Heerink, Zhao, & van der Werf, 2019; Nyawade et al., 2019). However, the limitation of information, counseling and training make farmers unable to manage the farming properly. Innovation and technology cannot be absorbed properly by farmers, it is proven that not all farmers are willing and able to apply technology.

The obstacles faced by highland potato farmers to increase production in addition to environmental conditions also caused by the weak managerial ability of farmers. Farmer's managerial ability depends on the characteristics of farmers and the ability to use technology. Farmers in the Bromo highlands are smallholder farmers and farmed for generations. The characteristics of smallholder farmers among others low education, limited capital, low knowledge, and application of technology. This characteristic will make different input allocation decisions. The difference in the allocation of inputs in each farmer determines the production achieved, if the expected production is not achieved meaning there is a technical inefficiency. The characteristics of farmers are closely related to the occurrence of technical definitions, for example socioeconomic factors, environmental factors, climate change and the use of technology (Otitoju & Enete, 2014).

The farmer's managerial ability besides seen from the characteristics of farmers and the application of technology; it is also related to how farmers respond to the existence of risks in agriculture. Agricultural business is always faced with a situation of risk and uncertainty, where the risk is largely sourced from climate change, pest attacks, plant diseases and environmental factors (Duong, Brewer, Luck, & Zander, 2019; Saqib, Ahmad, Panezai, & Rana, 2016). Agricultural activities are very dependent on the nature so that changes in natural conditions result in a decrease in total yield. Production risks faced by each farmer can be seen from the differences in production gains and income. The managerial ability of farmers to deal with risk is manifested in the strategies made in farming management so that its sustainability is guaranteed (Asravor, 2018; Fahad et al., 2018; Waduge, Edirisinghe, Fernando, Herath, & Jayasinghe-Mudalige, 2015).

Farmers' attitudes towards production risk are classified into three, namely risk taker, risk neutral and risk averse (Ellis, 1993; Hong et al., 2019; Kahan, 2013). Differences in risk preferences illustrate differences in decisions about the allocation of production inputs by farmers. The behavior of risk averse farmers acts not to optimize the existing inputs so that it will produce less production and of course lower income than farmers who are risk takers. Farmer's behavior towards production risk influences the amount of production input allocation, where the amount determines the level of technical efficiency (Ellis, 1993; Just & Pope, 1979; Kumbhakar & Tsionas, 2010).

The level of production is determined by the efficiency in allocating inputs into various alternatives of production activities. Therefore, efforts to increase production by applying the principle of allocation of optimal use of inputs become the key to the success of production improvement (Arru, Furesi, Madau, & Pulina, 2019). The allocation of the use of production inputs can be measured by the efficiency measurement of input use. One of the technical efficiency measurement methods used is through the frontier stochastic production function approach. Coelli (1995), explained that the frontier production function is the development of a deterministic model that measures unexpected effects (stochastic frontier) within the production limit. Research that discusses the technical efficiency of potato farming has been carried out (Aheisibwe, Lokina, & Hepelwa, 2018; Gebru, Mohammed, Dechassa, & Belew, 2017; Sapkota & Bajracharya, 2018).

From the explanation above, there is a relationship between farmers' risk preferences and technical efficiency in farming. In this study trying to find the effect of farmer risk preferences on the level of technical efficiency of farming, especially in the case of potato farming in the highlands. In addition, this research includes the application of technology, especially land conservation technology in the analysis, the aim is to obtain information about effects on the level of technical efficiency of highland agriculture. According to Adamie, Balezentis, & Asmild, (2018), explained that eliminating environmental factors in the efficiency analysis would result in policy making that not on target.

Materials and Methods

Production as object of determining risk preferences and measuring technical efficiency. Production is influenced by land area, inputs used, climate and technology. Production data were obtained from interviews with farmers. The production data used was the production in the planting season in March 2018.

Site Study and Sampling Techniques

The location determination conducted purposively in the Bromo highlands, with the consideration that this area was the center of Indonesian potatoes. In the Bromo Plateau there are many locations that became the centers of potato production. The chosen location was Wonokitri village, Tosari sub-district, Pasuruan Regency, East Java Province. This location selection the consideration is that this area has a high production risk because it is closest to Bromo Mountain and has a sharp land slope ranging from 45-60%. The research location is at an altitude of more than 1900 masl. The sample in this study was potato farmers at the time of the study. The number of samples was 83 people chosen randomly from 186 farmers.

Figure 1. Map of the research location (located in the Bromo plateau)

Risk Preference Analysis Method

The analysis used is a risk function model developed by Kahan (2013). In this analysis the farming risk is assumed input and output in a competitive market so that the price is known with certainty or there is no price risk. Another assumption the farmer in conducting their farming is trying to maximize the utility where maximizing this utility uses the income maximization approach in farming, and farmers get production output y at the price level p. Utility maximization (expected utility) which is a function of normalized expected profit. The utility function can be written as $E = \left[U\left(\frac{\pi^e}{p}\right)\right]$. Expected profit ($\pi^e$), formulated as follows:

$$\pi^e = py - w'x = pf(x,z) - w'x + pg(x,z)\varepsilon$$

Where:

π^e = expected profit

p = output price (Rp)

y = production/output

w = variable input price vector (w_1,..........., w_j)

x = number of inputs used

Normalized expected profit is formulated as follows:

$$\frac{\pi^e}{p} = y - \frac{w'}{p} = f(x,z) - \frac{w'x}{p} + g(x,z)\varepsilon = f(x,z) - \widetilde{w'}x + g(x,z)\varepsilon$$

$\widetilde{w}$: vector of normalized input prices $\widetilde{w_j} = \frac{w_j'}{p}\ \forall j = 1, \dots \dots . j$

Assuming the producer maximizes the expected utility from the normalized expected profit $E = \left[U\left(\frac{\pi^e}{p}\right)\right]$, then *first-order condition* (FOC):

$$E\left[U'\left(\frac{\pi^e}{p}\right)(f_j(x,z) - \widetilde{w_j} + g_j(x,z)\varepsilon\right] = 0 \quad \forall j = 1, \dots . . j$$

Where:

$U'\left(\frac{\pi^e}{p}\right)$ = marginal utility of normalized expected profits

f_j = first derivative from the production function toward input variable -j

g_j = first derivative from the production variability function of input variable -j

To obtain the function of behavior towards risk:

$$f_j(x,z) = \widetilde{w_j} - g_j(x,z)\frac{E\left[U'\left(\frac{\pi^e}{p}\right)\varepsilon\right]}{E\left[U'\left(\frac{\pi^e}{p}\right)\right]} = \widetilde{w_j} - g_j(x,z)\theta_1 \ \ \forall j = 1, \dots . . j$$

Where:

$$\frac{E\left[U'\left(\frac{\pi^e}{p}\right)\varepsilon\right]}{E\left[U'\left(\frac{\pi^e}{p}\right)\right]} = \theta_1$$

And the value of θ_1 is the value of behavior towards risk.

So that the function of attitudes towards risk:

$$f_j = \widetilde{w_j} - g_j\theta_1$$

If $g_j > 0$ *and* $\theta_1 < 0$ => $f_j < \widetilde{w_j} - g_j\theta_1$ => f_j must increase so that $f_j = \widetilde{w_j} - gh_j\theta_1$, or input x_1 must decrease. Then: $g_j > 0$ and $\theta_1 < 0$ then the producer behaves *risk averse* $g_j > 0$ and $\theta_1 > 0$ then the producer behaves *risk taker*

If $g_j < 0$ *dan* $\theta_1 > 0$ => $f_j < \widetilde{w_j} - g_j\theta_1$ => f_j must increase so that $f_j = \widetilde{w_j} - g_j\theta_1$, or input x_1 must increase. Then: $g_j < 0$ and $\theta_1 > 0$ then the producer behaves *risk averse* $g_j < 0$ and $\theta_1 < 0$ then the producer behaves *risk seeking* or *risk taker*

Technical Efficiency Level Analysis Method

The production function model used in the measurement of technical efficiency is the Cobb Douglas production function with the Stochastic Production Frontier approach. Measurement of technical efficiency of potato production is measured using the following formula (Coelli, 1995):

$$TE = \frac{y_i}{y_i^*} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i)$$

Where y_i is actual production from observations, y_i^* is potential production estimation from stochastic frontier functions. Technical efficiency for a farmer is ranges from 0 and 1. The technical efficiency has a value that is the opposite of the effect of technical inefficiency.

Method Analysis of factors on the level of technical efficiency

In estimating the factors that influence the level of technical efficiency used a Tobit regression model. In estimating Tobit regression parameters used MLE *(Maximum Likelihood Estimator)*. The factor estimation model that effects on the level of efficiency uses the Tobit regression model namely:

$TE = \delta_0+\delta_1Z_1+\delta_2Z_2+\delta_3Z_3+\delta_4Z_4+\delta_5Z_5+\delta_6Z_6+\delta_7D_1+\delta_8D_2+\varepsilon$

Where:

TE : the value of technical efficiency, Z_1: farmer age (year), Z_2: length of education (year), Z_3: farming experience (year), Z_4 : family size (person), Z_5 : The frequency of counseling and training participated by farmers during the growing season (number 1,2 ,3...), Z_6 : Land slope (%), D_1: terrace system, 1 if applying a terrace system and 0 if not, D2: risk preference valued 1 = risk taker and 0 = risk averse, δ_n : parameter coefficient of the estimated variable, ε : random error term which is assumed independent and distributed freely and its distribution is cut normally with N $(0, \delta)$.

This technical efficiency analysis is intended to determine the level of technical efficiency in the study area. The analysis of technical efficiency in this study uses the frontier production stochastic approach which is analyzed using the Frontier 4.1 program.

Results and discussion

Table 1. Potato production based on farmer information.

Production (Tons)	No. of respondents
≥ 5.0	3
5.1 – 7.5	13
7.6 – 10.0	8
10.1 – 12.5	16
12.6 – 15.0	16
15.1 – 17.5	5
17.6 – 20.0	4
20.0 ≤	18
Total	83

Based on Table 1, the potato production of respondent farmers shows 18 farmers produce potatoes above 20 tons. The average production of respondent farmers is 19.2 tons/hectare. Potato production for each farmer is different, this is influenced by land area, technology, climate and use of production inputs. Differences in potato production at the farmer level also indicate the level of technical efficiency of farmers in farming and farmers' responses to the production risks.

Respondents' Risk Preference

The analysis model for determining risk preference is a model developed by (Kahan, 2013), based on utility function derivatives. The stages in this analysis are analyzing the production function and risk function from the Just and Pope model first. Then the estimation results are used to analyze the behavior of farmers towards production risk. The estimation result of the coefficient parameters of the production function and risk function are included in the expected and normalized profit function. Table 2 shows the estimation results of the production function and risk function.

Table 2. The estimation of coefficient of production function and risk function parameters uses multiple regression.

Variable	Estimation of Production Function		Estimation of Risk Function	
	Coefficient	S.E.	Coefficient	S.E.
Constants	3.86	0.98	0.35	0.58
Land Area	0.55	0.14	-0.01	0.08
Seed	0.31	0.12	0.01	0.07
Chemical Fertilizer	0.11	0.11	-0.03	0.06
Manure	0.15	0.08	-0.04	0.05
Pesticide	-0.36	0.19	0.05	0.11
Labor	0.38	0.13	0.05	0.08
R-square	0.92		0.02	
F-calculate	149.24		0.32	

In here does not explain the effect of the estimation results, because the main purpose of the production function and risk function analysis is to find out the magnitude and the parameters coefficient sign of each variable, then the results are used to determine the risk preferences of farmers using the utility function with the normalized profit function approach. The results of the analysis can be seen in Figure 3.

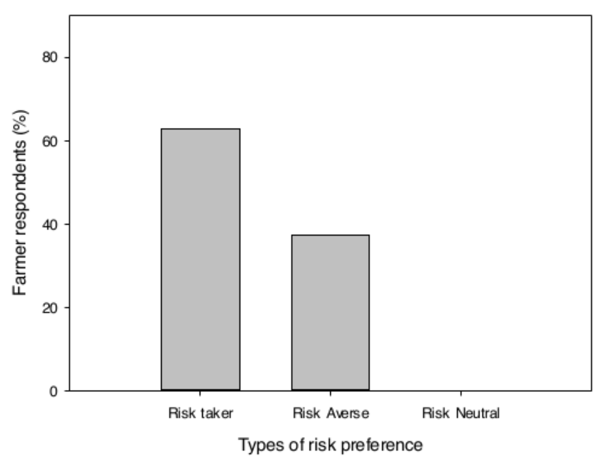

Figure 3. Percentage of farmer respondents based on risk preferences

Figure 3 describes that percentage of risk takers towards production risk are 62.65% (52 respondents) and percentage of risk averse are 37.35% (31 respondents). Farmers are more likely to behave risk takers because of environmental factors that support potato farming. The research location at an altitude of more than 1900 meters above sea level and located on the slopes of the volcano allows it to have fertile soil conditions and climatic conditions that are still in accordance with potato cultivation. Farmers at an altitude of more than 1900 masl assume that the profession as a farmer is the main profession even though there are some who have jobs outside of agriculture. Farmers at this height are hereditary a farmer so that the existence of various obstacles in farming, they try to find solutions and are active in training and counseling. Farmers dare to invest in technology because they have the notion that being a farmer is a job that must be preserved as an ancestral heritage, and it is proven that this work provides sufficient income for family needs. The technology investment which conducted now is the cooperation in the procurement of superior seeds, both with the local government or with the private sector, besides that cultivation technology innovations have been developed, one of them is the use of mulch and a terrace system. The results of this study reinforced by statements from (Kidane, Lambert, Eash, Roberts, & Thierfelder (2019) that farmers in the lower plains are ambiguous towards production risk. However, this research contradicts with several other studies stating that farmers tend to be risk averse (Ahmad, Afzal, & Rauf, 2019; Chen, Zeng, Xu, & Fan, 2018; Erny, Darwanto, Masyhuri, & Waluyati, 2019; Fausayana et al., 2017).

Technical Efficiency of Potato Farming

The analysis shows the average level of technical efficiency in the altitude area of more than 1900 masl is 0.774 (Figure 3B). This means that farmers in the research location are not yet technically efficient. The results also show that farmers' ability to manage inputs needs to be improved to produce optimal output. Farmers are still able to increase their production by 22.6%.

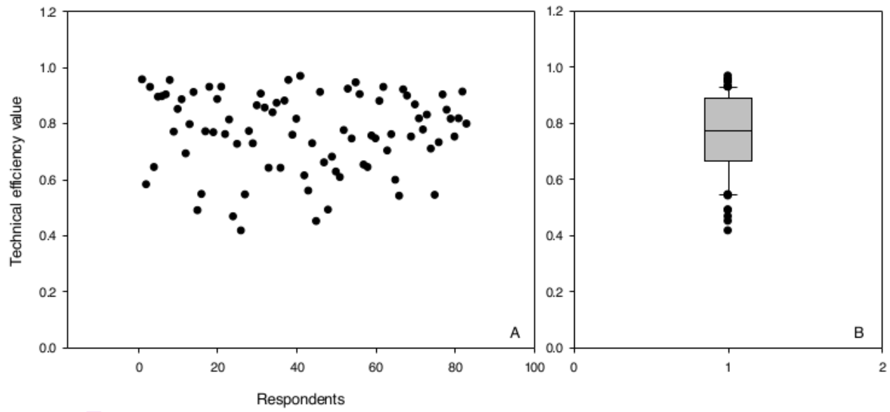

Figure 4. Distribution of technical efficiency (TE) value of respondents (A) and TE boxplot based on farmer respondents

The distribution of technical efficiency of potato farmers can be seen in Figure 4. The number of farmers who have a level of efficiency above the average value amounted to 50.6% and below the average 50.4%. This number indicates a gap in the value of technical efficiency. This gap occurs because of differences in the allocation of production inputs in each farmer. In addition, the existence of different managerial abilities of farmers in managing farming.

Factors that affect technical efficiency

Factors that influence technical efficiency or the occurrence of technical inefficiencies in this study are age, education, farming experience, family size, frequency of counseling and training, land slope, application of the terracing system and farmers' risk preferences. Risk preference in the study area has been determined in the previous chapter that respondents behave as risk takers and risk averse. The results of the analysis of these factors on the level of technical efficiency can be seen in Table 2.

Table 2. Results of Analysis of Factors that influence Technical Efficiency

Independent Variable	Coefficient	Std. Err	t-value	P>|z|	dy/dx
constants	0.6643	0.1219	5.45	0.000	
Age	0.0018	0.0021	0.88	0.383	0.0018
Education	0.0104	0.0052	2.00	0.049*	0.0104

Farming experience	-0.0005	0.0017	-0.33	0.739	-0.0005
Number of family members	0.0854	0.0076	1.12	0.266	0.0085
Frequency of Counseling and training	0.0436	0.0111	3.94	0.000***	0.0436
Land slope	-0.0056	0.0014	3.44	0.000***	-0.0056
Dummy terrace	0.0362	0.0214	1.69	0.095*	0.0362
Production risk behavior	0.0167	0.0216	0.77	0.441	0.0167
Number of observations	= 83				
LR Chi^2	= 83.56				
Prob > chi^2	= 0.000				

Note: * significant at α = 0.1; ** significant at α = 0.05; *** significant at α = 0.01

Parameters testing simultaneously carried out to determine whether the parameters used simultaneously have a significant effect on the model. The statistical test used is the Likelihood Ratio Test. In Table 2 shows that the Likelihood Ratio test value equal to 83.56 with a probability of 0.0000 means that together the independent variable (X) in the model can represent the value of Y, namely the level of technical efficiency. In Table 4 shows that the factors that have a significant positive effect on the level of technical efficiency are education, frequency of counseling and training, dummy of terrace system, while which has a significant negative effect is the land slope.

Education level become an indicator of the diffusion power and adoption of agricultural technology. Education level become an indicator of the diffusion power and adoption of agricultural technology. The level of education affects the quality of human resources, where the higher the level of education, in general, the higher the quality of human resources. Higher education is easier to accept and apply farming technology. Farming management is more efficient because farmers tend to have greater motivation for the progress of their farming. Education is important because it is considered as a means of investment where higher education can help improve the knowledge, skills, and expertise of farmers as capital to work more productively so that they can improve their managerial skills and income in the future. The respondent who had been educated for 6 years or equivalent to elementary school amounted to 48.2% while those who had an education above equal to 39.8% and the rest had never educated or did not complete primary school. From the analysis results education has a positive effect on the level of technical efficiency, meaning that farmers who take higher education have greater efficiency level. The data shows that farmers that have an education above primary school are more less, but they are trying to maximize their ability to manage their farming in various ways including the application of cultivation technology and trying to obtain information and increase skills by attending counseling and training. The results of this study are in line with several studies which state that education has an effect on the improvement of technical efficiency (Anang, Bäckman, & Sipiläinen, 2016; Dessale, 2019).

The frequency of counseling and training, is an important tool in building farmer managerial capacity (Dessale, 2019). The research results showed that the frequency of counseling and training had a significant positive effect on the technical efficiency of potato farming. This means that counseling and training participated by farmers increase the level of technical efficiency of potato farming. The value of marginal effects on the variable of frequency of counseling and training is 0.0436 meaning that each increase of one frequency of counseling and training which followed by farmers, the change in the level of technical efficiency increases by 4.36%. Farmers actively participate in counseling and training held by the government or other institutions. Farmers understand that counseling and training are useful for their agriculture, especially regarding the application of technological innovations. Sapkota & Bajracharya (2018), explained that farmers' knowledge must be adequate in potato farming, increasing knowledge can optimize the use of resources to help increase potato production. Counseling and training are a means for farmers to obtain information about potato farming from the aspects of cultivation, marketing and other information that farmers need. This activity is routinely carried out every month at least once by farmer groups or scheduled by field extension officers. Fillers/speakers can come from the government, academics, the private sector, or the officials themselves. This activity is largely an initiative of the farmers due to the geographical condition of Tosari which is far from downtown Pasuruan and the difficulty of getting information from information technology. Farmers participate in counseling and training activities ranging from 0-7 times in a single growing season. For farmers at an altitude of more than 1900 meters above sea level this activity is carried out an average of 3 times. Besides participating in extension activities and training held in the Tosari sub-district, there are also some farmers who take part in training outside the sub-district.

Agriculture in the Tosari sub-district is on the slopes of the Bromo mountain which has a sloped topography, land slope at an altitude of more than 1900 masl between 45% - 60%. This slope has consequences for soil erosion. The steep slope of the land accelerates the rate of erosion and accelerates the occurrence of land degradation namely a decrease in land quality. Nyawade et al. (2019) in his research stated that the area of potato cultivation in East Africa has a rough topography and high soil disturbance resulting in loss of nutrients and erosion. Steep slopes require technology that can prevent erosion, for example with perennials as soil reinforcement, mulch use or terrace system. Erosion that occurs will harm farmers because the plant growth is not optimal so that it affects crop yields or causes crops to damage and crop failure. Several potato farmers in research area have implemented land conservation technology. Land conservation technologies that have been applied among others the application of terrace systems. The terrace system is adjusted to the level of the land slope. Farmers at the study site used the gulud terrace system. The gulud terrace system is making mounds / guludan in the direction of the land contour and making an irrigation flow under the mounds / guludan. Most farmers have used the terrace system in the cultivation of potatoes, namely 66 people or 79.5%. The results showed the land slope was significantly negative towards the level of technical efficiency, meaning that if the land gets steeper than the level of technical efficiency is lower. The value of marginal effects on the variable slope equal to -0.0056 means that each increase in one degree of land slope then the changes of technical efficiency level decreases by 0.56%. This results is consistent with Mirie, Dessie, & Mekie (2019) states that land slope is negatively related to technical efficiency. The steep slope of the land makes it difficult for farmers to take care of plants such as pesticides, higher ground with steep slopes, many plants are unreachable and require a long time in pesticide spraying. In addition, steep slopes require more labor in the harvesting process.

The terrace system is one of the land conservation technologies that is practiced at the study site. Terrace dummy shows a significant positive effect on technical efficiency. The marginal effects value on the terrace dummy variable is 0.0362 which means that farmers who apply the terrace system will tend to be efficient in farming with a value of change amounted to 3.62%, means that farmers who apply terracing will tend to be more efficient in their farming. Making a terrace for sloping land is necessary, to prevent erosion and landslides because if a landslide occurs, the potato tubers in the ground will disappear and crop failure.

Farmers' behavior towards production risk in this study is categorized into two, namely risk takers and risk averse, this refers to the results of research where farmers in the research location behave risk averse and risk takers in dealing with production risks. The analysis shows that the risk preference variable on production risk has no significant effect and has a positive sign. However, several studies stating that risk taker farmers in the allocation of production inputs are more efficient than risk averse farmers (Alam, Guttormsen, & Roll, 2019; Ellis, 1993; Kumbhakar & Tsionas, 2010). Farmers who are risk takers tend to be efficient because they have the ability to improve their farm management strategies by applying technology, following counseling and training. Asravor (2018) states that farmers who are risk averse try to improve farming management strategies. Liu, Langemeier, Small, Joseph, & Fry (2017) states that farmers who are risk averse tended to use superior seeds and benefited from the choice namely an increase in income.

Conclusions

Agricultural production results from a combination of production factors used such as land, labor and capital (seeds, fertilizers, pesticides). Suboptimal production is an indication of technical inefficiencies in farming. The analysis result shows that farmers tend to be risk takers namely 62.65% of the respondents and risk averse equal to 37.35%. The average efficiency level of respondent is 0.774, which means that farmers are still not efficient in the allocation of production inputs. The factors that have a significant positive effect on technical efficiency are education, frequency of counseling and training and application of the terracing system, while the slope of the land has a significant negative effect. Therefore, to increase production and income of potato farmers in the research location it is necessary to have intensive scheduled counseling and training considering that the education level of farmers is mostly still at the elementary school level. Application of land conservation technology is very important to overcome the slope of the land. The improvement of farmer managerial ability can increase the ability of farmers to respond to the occurrence of production risk sources so that farmers more efficiently manage their farming.

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