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# The Risk Behavior Analysis Of Potato Farmers In Merangin District, Jambi Province

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**Abstract – Farmer risk is an important analysis to find out farmers' preferences for agricultural production activities. This is related to farmers' behavior regarding the use of poor commodity production input factors with unknown climate changes, especially in the case of commodities whose harvest period is monthly. This research aims to analyze the risk behavior of potato farmers during the rainy season and dry season in Merangin Regency, Jambi Province. The analytical method used is the frontier production function model to analyze the risk preferences of 102 potato farmers. It has been demonstrated through the findings of the research that farmers exhibit risk-averse behavior in relation to the overall use of production inputs, regardless of whether the season is rainy.**

**Keywords – Dry Season, Rainy Season, Risk Behavior, Technical Efficiency**

## I. INTRODUCTION

Agriculture is a highly precarious commercial sector, influenced by both human and environmental forces. The technical and allocative efficiency of farming is influenced by the administrative qualities of farmers. Integrated learning can help mitigate human resource risks, but natural resource risks, exacerbated by climate change, provide significant challenges to manage (Asmara and Widyawati 2019). Climate change, as a result of human activities, increases global average temperatures and affects agriculture in Indonesia. The impacts include reduced production, productivity, and the risk of crop failure (Nurdin 2011; Hidayati and Suryanto 2015; Syaukat 2011; Surmaini et al. 2017). Potatoes, as an important food crop, are also affected, especially by changes in the intensity of pest and disease attacks. Potato production is extremely vulnerable to a range of non-living elements, such as climate change, fluctuations in temperature, and levels of saltiness in the soil. Severe weather conditions can lead to a decrease in agricultural production by as much as 25% or even more (van der Waals et al., 2016).

Climate elements, including precipitation, temperature, CO2 levels, solar radiation, frost, drought, and salinity, play a pivotal role in shaping the growth phases and overall development of potatoes, significantly influencing their growth rate (Adekanmbi et al. 2023; Jennings et al. 2020; Raymundo et al. 2018).

Potatoes in Indonesia are not only a staple food besides rice, but also support food diversification and nutritional needs. With high economic value, potatoes play a strategic role in achieving sustainable food security and controlling inflation rates (Rahayu et al. 2015; Badan Ketahanan Pangan 2020).

The potato production in Indonesia is still limited, at 1,503,998 tons, with a planting area of 76,728 hectares, and an average productivity of only 19.54 tons per hectare. The potato production is unable to meet the domestic consumption level, which reaches 3,167 kg per capita per year, with a total population of around 275.77 million. Therefore, the estimated potato consumption in Indonesia reaches about 6,160,560 tons per year. During the period from 2018 to 2022, the average growth of potato consumption in Indonesia reached 8.9%, while the production growth was only about 6.9% (Pusdatin, 2022). This high consumption rate, without being matched by adequate production growth, has the potential to cause issues. Therefore, steps are needed to increase production to accommodate the consumption needs.

Jambi Province, as the largest potato production center in Sumatra and fourth in Indonesia, recorded production value growth of 12.28 percent in 2021. Despite experiencing an increase in production from 2017 to 2019, this province experienced a significant decline of 38.05 percent in 2020. caused by a decrease in potato harvest area. Potato productivity in Jambi remains high, reaching 18.3 tonnes/ha, exceeding the national average of 17.46 tonnes/ha. This productivity growth was 2.5 percent during the 2017-2020 period (Statistics Indonesia in Jambi Province 2022). One of the potato production centers in Jambi, Merangin Regency, has a lower average productivity. In 2021, potato productivity in Merangin Regency will reach 16.96 tons/ha, while the average productivity in Jambi is 17.84 tons/ha. Despite falling below the national average of 17.46 tons/ha, potatoes in Merangin Regency account for 21.9 percent of the overall production of vegetable and fruit crops, according to Indonesian statistics in Merangin Regency. Potato farmers in Merangin Regency face numerous obstacles, including risks, significant land conversion, insufficient use of agricultural technology, weak farming institutions, limited access to capital and land, high costs for seeds, fertilizers, and pesticides, and a shortage of labor.

Risk concerns play a crucial role in potato farming since they have a significant impact on both production outcomes and the decision-making process of farmers regarding the usage of inputs. The risk preferences of farmers play a crucial role in the effective adoption of various input technologies. Due to their nature as a horticulture commodity, potatoes are inherently prone to quick decay, injury, and significant reduction in size. These factors give rise to concerns regarding both physical and financial risks (Saptana et al., 2006). In facing risk, farmers need to make strategic decisions in the allocation of production inputs, which is the main key to achieving optimal production and influencing production results. (Just and Pope 1979) state that in almost every agricultural production process, production risk is an important factor in allocation decisions input use, which impacts the level of productivity achieved. Farmers' decisions regarding risk are influenced by the inherent nature and utility of produce, influencing their strategy and input allocation. This difference has an impact on farmer productivity and efficiency (Saptana et al. 2010; Kurniati 2015). Based on the description above, this research aims to analyze farmer risk behavior in the rainy season and dry season.

## II. METHODOLOGY

The study was carried out at Merangin Regency, located in Jambi Province. The research utilizes primary data in the form of panel data obtained through direct interviews with potato growers using questionnaires. The secondary sample method employed is purposive sampling. The research participants consisted of farmers who cultivated potatoes during both the wet and dry seasons. They were purposively selected from three specific sub-districts: Jangkat District, Jangkat Timur District, and Lembah Masurai District. The research sample consisted of 102 respondents from October to December 2022. The model developed by Kumbhakar (2002) is used to analyze the impact of input allocation on production, the impact of input allocation on production risk and farmers' preferences for potato productivity risk. The functional form is:

$$Y = \alpha_0 \prod_{i=1}^{k} X^{\alpha_i} + \beta_0 \prod_{i=1}^{k} X^{\beta_i} e^{v_i} - \gamma_0 \prod_{i=1}^{k} X^{\gamma_i} e^{u_i}$$

Where : $\alpha_0 \prod_{i=1}^{k} X^{\alpha_i}$ = Production function; $\beta_0 \prod_{i=1}^{k} X^{\beta_i} e^{v_i}$ = Risk Function; $\gamma_0 \prod_{i=1}^{k} X^{\gamma_i} e^{u_i}$ = inefficiency function. Yi = potato production (kg); α = Production function parameters; β = Product risk function parameters; γ = Inefficiency function parameter; X1 = land area (ha); X2 = seeds (kg); X3 = N fertilizer (kg); X4 = P fertilizer (kg); X5 = K fertilizer (kg); X6 = Solid pesticide (kg); X7 ; Liquid pesticide (ltr); X8 = Workforce in the family (TKDK) (HOK); 9 = Workers outside the family (TKLK) (HOK); vi = error term indicating production uncertainty, assumed i.i.d (0, σvi)2; shows technical inefficiency assuming identical distribution or i.i.d (0, σui)2 and ui > 0, ui is independent of vi. The analysis stages carried out for the production function model, risk function and technical inefficiency function using the Maximum Likelihood Estimation (MLE) method through the Frontier 4.1 and SAS 9.4 programs. There are farmer's risk selection criteria are:

1. If θ = 0 and λ = 0 then farmers are risk neutral
2. If θ < 0 and λ > 0 then the farmer is a risk taker
3. If θ < 0 and λ > 0 then the farmer is a risk averter.
4. If farmers are at full efficiency (u = 0) then the producer's risk behavior is determined by θ

## III. Results And Discussion

Table 1 shows that the usage of potato production inputs by farmers does not show a significant difference in average production between the rainy season and the dry season. Farmers typically cultivate an average of 0.73 hectares of land with potatoes during the wet season, compared to 0.69 hectares during the dry season. While there is no significant statistical disparity, the extent of land dedicated to potato cultivation is greater during the wet season. The inability of farmers to allocate costs for input when the field size is increased is due to financial restrictions. Rainy season farmers use the most seeds, an average of 1,957 kg/ha, while in the dry season it is lower, 1,919 kg/ha. On average, farmers choose seeds from the previous harvest with a size of 40 grams per grain (2000-2500 kg/ha). Farmers' usage in seeds, both in the rainy and dry seasons, is not as recommended. The low use of seeds at the research location is due to the high price of seeds and the difficulty of obtaining certified seeds at high costs. Even though statistically it is not significantly different, the amount of seed used is still higher in the rainy season at 38 kg (1.94%) than in the dry season.

**Table 1.** Production input for potato farming

| Input | Production Input Usage | | | | |
|---|---|---|---|---|---|
| | **Unit** | **Rain Season** | **Dry Season** | ***t-test*** | ***Sig(2-tailed)*** |
| Production | kg/ha | 21,619 | 22,778 | -1.21 | 0.230 |
| Land Size | ha | 0.73 | 0.69 | 0.43 | 0.672 |
| Seeds | kg | 1,957 | 1,919 | 1.01 | 0.316 |
| Fertilizer N | kg | 96 | 86 | 0.39 | 0.697 |
| Fertilizer P | kg | 192 | 174 | 0.12 | 0.906 |
| Fertilizer K | kg | 92 | 89 | 0.03 | 0.974 |
| Pesticide Solid | kg | 24.3 | 16 | 3.25 | 0.002 |
| Pesticide Liquid | ltr | 15.8 | 7.55 | 4.64 | 0.00 |
| TKDK | HOK | 51 | 31 | 4,59 | 0.000 |
| TKLK | HOK | 248 | 239 | 0.90 | 0.372 |

Source: Data Processed (2022)

The input variables used in potato farming during both the rainy and dry seasons include land, seeds, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid pesticides, labor within the family (TKDK), and labor outside the family (TKLK). Urea, SP-36, KCL, Phonska, and NPK Mutiara fertilizers are grouped based on the content of Nitrogen (N), Phosphorus (P), and Potassium (K) as active substances, considering that many farmers do not use complete fertilizers

Farmers usage in solid fertilizers such as Urea, SP 36, Phonska, KCl, and Fertiphos in varying doses due to differences in soil fertility, constraints on fertilizer availability which results in expensive fertilizer prices which have an impact on farmer household finances. Its difficulties for farmers in allocating costs and proportions of fertilizer in a balanced manner. The average amount of nitrogen fertilizer (N), phosphorus fertilizer (P), and potassium fertilizer (K) used by farmers in the rainy season is almost the same as the amount used in the dry season. Statistical tests showed that there were no significant differences at the 1% confidence level in the amounts of N, P and K fertilizer used in the two seasons. The recommendation in dose of N fertilizer is

100-150 kg/ha or the equivalent of 217-326 kg/ha of Urea, 150-200 kg/ha of P fertilizer or the equivalent of 416-555 kg/ha SP 36 and 100-100 kg of K fertilizer. 150 kg/ha or equivalent to 166-250 kg/ha KCl.

Statistically, there is a significant difference at the 1% confidence level, both in solid and liquid form. Farmers use more liquid pesticides in the rainy season, with an increase of 8.25 liters or 52.21% compared to pesticide use in the dry season. Likewise with the use of solid pesticides, which increased by 8.3 kg or 34.16% in the rainy season. The high level of pesticide spraying during the rainy season is caused by farmers' efforts to anticipate pest or disease attacks. The common disease that affects potato plants is leaf blight. Leaf blight is caused by an attack of the fungus Phytophthora infestans. Research (Purwantisari and Hastuti 2009) reported that during the rainy season, the incidence of Phytophthora infestans fungus reached 40 to 90% in Wonosobo.

Using labor in potato farming involves various activities, from land preparation to harvest. This process requires labor from the farming family and outside the family. Women's labor is more dominant at certain stages, such as planting seeds, caring for plants, harvesting, and post-harvest. The male workers dominate activities such as tilling the land, fertilizing, spraying, and transporting harvests. TKDK use in the rainy season averages 51 HOK/ha, 31 HOK/ha, or 39.21% higher than TKDK use in the dry season. Statistical tests show a significant difference at the 1% level in TKDK time between the rainy and dry seasons. Labor in the family is needed to monitor and protect plants from pests and disease during the rainy season because the rainy season can increase the risk of disease and pest attacks on plants. There is no statistical difference in the use of outside family workers (TKLK), both in the rainy and dry seasons. However, the use of TKLK in the rainy season is 248 HOK/ha or 3.63% higher than the use of TKLK in the dry season.

The model analysis has nine production input variables, including land, seeds, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid pesticides, labor within the family (TKDK), and labor outside the family (TKLK). Urea, SP-36, KCL, Phonska, and NPK Mutiara fertilizers are grouped based on the content of Nitrogen (N), Phosphorus (P), and Potassium (K) as active substances, considering that many farmers do not use complete fertilizer. Analysis of production functions, production risks, and technical inefficiencies in the rainy and dry seasons produces variable estimates in Table 2. Analysis of production functions shows that land area and seed use significantly positively affect (at $\alpha$ 1% and $\alpha$ 5%) potato production in both seasons. In the dry season, land area has the highest elasticity, namely 0.98 and 0.82, indicating the most significant influence on potato production. The land area coefficient indicates that a 1 percent increase in the land area will increase potato production by around 0.98% and 0.82%, assuming cateris paribus. Even though land area increases production, farmers continue to work according to financial capabilities and plant other crops to reduce price risk. The increase in land area must be accompanied by increased use of inputs and appropriate management. These findings are consistent with the research results of Maryanto et al. (2018), which stated that increasing land area by 1% will increase production by 0.1999%. Other research, such as (Nugraheni et al. 2022; Maganga, 2012; Karimov, 2013 Alam et al., 2012), also strengthens that the land area variable significantly and positively affects potato production.

The second factor with high elasticity is seeds, which have an elasticity of 0.27 and 0.34, meaning that an increase in seeds of 1% increases potato production by around 0.27% and 0.34%, assuming cateris paribus. The current average use of potato seeds is 1900 kg/ha, while the recommendation is 1200-2000 kg/ha. Farmers can increase the use of seeds to increase production by other research findings (Maryanto et al., 2018; Andaregie & Astatkie 2020; Maganga 2012), which show that the use of potato seeds has a real and positive effect on production.

The TKLK variable in the rainy season and dry season has a significant negative effect on potato production, in contrast to production theory, which states it should have a positive effect. TKLK does not pay enough attention to potato farming and does not have an emotional connection to the plant. The higher wage costs for TKLK during the rainy season, even though they do not work full time due to rainy conditions, are another factor. The negative impact of the TKLK variable is suspected because in the research area, farmers still use a communal system in carrying out farming activities. Therefore, the increasing number of workers tends to not actively contribute to the work, and these findings are in line with research by Kune et al. (2016). These results contradict the research of Sahara et al. (2023), which states that labor has a real and positive effect on potato production.

**Table 2**. Estimation of production elasticities, risks and technical inefficiencies

| Variable | Rainy Season Potato Farming | | | Dry Season Potato Farming | | |
|---|---|---|---|---|---|---|
| | Production Function | Risk Function | Inefficiency Function | Production Function | Risk Function | Inefficiency Function |
| Konstanta | 8.67 | 13.036 | -1.491 | 7,54 | 7.714 | -1.819 |
| Land Size | 0,.98 [b] | 0.386 | 0.044 | 0,82 [b] | 0.705[c] | -0.308 [a] |
| Seeds | 0.27 c | 0.088 | -0.174 | 0,34 [b] | 0.349[c] | 0.125 |
| Fertilizer N | -0.25 | -0.760 [a] | -0.491 [a] | -0,28 [b] | -0.245 | -0.268 [a] |
| Fertilizer P | 0.11 | -0.136 | -0.244[c] | 0,05 [c] | -0.340[b] | -0.125 [a] |
| Fertilizer K | 0.05 | -0.035 | 0.292 [d] | 0,06 | -0.103 | -0.065[c] |
| Pesticide Solid | -0.06 | -0.150 | -0.033 | -0,09 | -0.274[c] | -0.131 [a] |
| Pesticide Liquid | 0.05 | -0.360[c] | 0.002 | 0,07 | -0.093 | -0.114 [a] |
| TKDK | 0.11 | -0.403 [d] | -0.388[c] | -0,03 | -0.135 | -0.124 [a] |
| TKLK | -0.12 [d] | -0.229 | 0.461 [a] | -0,17 [c] | 0.320[c] | -0.036 |
| LR | 16.65 | | | 11,518 | | |

Note: Significant at $\alpha^d$ = 10%, $\alpha^c$ = 5%, $\alpha^b$ = 1%, and $\alpha$ $^a$=0.1%

Source: Data Processed (2022)

The use of N fertilizer in the rainy season and dry season has a natural effect with a negative sign, indicating that an increase of 1 percent will reduce potato production by around 0.25% and 0.28%, assuming cateris paribus. It is contrary to production theory, which expects positive signs. The recommended dose of N fertilizer by BPTP Jambi is 100.5 kg per hectare, but farmers, on average, use 96 kg per hectare, less than the recommended dose. On the other hand, using P fertilizer has a significant effect with a positive elasticity of 0.11 and 0.05, indicating that adding P fertilizer can still increase potato production. The average use of P fertilizer is close to the recommended dose, but fertilizer availability is an obstacle, so farmers use fertilizer compositions that do not match the recommended dose, but fertilizer availability is an obstacle, so farmers use fertilizer compositions that do not match the recommended dose. The addition of P fertilizer will increase vegetative growth and potato production (Karo 2018).

The use of solid pesticides in the dry season has a significant negative effect on potato production, indicating that the addition of solid pesticides can reduce production. This result is contrary to production theory which should show a positive influence according to the Cobb Douglas function assumption. According to information from PPL, farmers use pyrethroid class insecticides not according to the recommended dosage, which can accelerate the development of pest strains that are resistant to insecticides and have an impact on potato production.

The results of the difference test show a significance value (2-tailed) of 0.701, meaning that there is no statistically significant difference between the production achieved by potato farming in the rainy season and the dry season. Based on Table 2 on the risk function, variables with positive coefficients increase production risk (risk increasing), while variables with negative coefficients reduce production risk (risk decreasing). The results of risk function estimation in the rainy season show that the addition of N fertilizer, liquid pesticide, and TKDK has a significant effect at the significance levels $\alpha$ = 0.1%, 5%, and 10%. This indicates that the addition of N fertilizer, liquid pesticide, and TKDK reduces production risk. N fertilizer is considered a risk decreasing input. Although this result is not in line with the estimated frontier production function which shows a decrease in potato production due to the addition of N fertilizer, it is likely caused by the use of N fertilizer that exceeds the recommended dose, affecting potato growth and production. Previous research also shows that fertilizer can reduce the risk (Guan and Wu 2009; Fauziyah 2010).

The addition of liquid pesticides has a significant effect on reducing production risk, indicating that liquid pesticides are a risk decreasing input. The results of the estimation of the production risk function are supported by the results of the estimation of the frontier production function, where the addition of liquid pesticides results in an indirect increase in potato production because it avoids pest attacks and diseases that can affect potato production. Previous research also shows that fertilizers and pesticides are inputs that reduce risk (Guan and Wu 2009; Fauziyah 2010). Family participation in the workforce (TKDK) has a real effect on reducing production risks. Family involvement in farm management makes them more flexible to changes in crop or weather conditions, reducing production risks. This finding is in line with previous research (Fauziyah 2010; Qomaria 2011) which shows that labor can act as a risk reducing factor. The results of risk function estimation in the dry season show that additional land, seeds and TKLK can increase production risk at a significance level of α 5%. On the other hand, the addition of P fertilizer and solid pesticides can reduce production risk at a significance level of α 5%. Positive coefficients for the land and seed variables indicate that both are risk-increasing inputs in the production process. Farmers are reluctant to plant potatoes widely (on average 0.69 ha) due to high cultivation costs, in accordance with previous research findings (Villano et al 2005); (Jufri et al. 2018); (Pamusu et al. 2019); (Tiedemann and Lohmann 2013). Farmers are more likely to use potato seeds from previous harvests due to high seed prices and difficulties in obtaining certified seeds. This policy can increase the risk of plant susceptibility to disease and result in reduced productivity.

The use of seed in potato cultivation increases production risks because farmers generally use seeds from their own harvested tubers or purchase them from other farmers without adequate knowledge of their origins. This results in a lack of assurance regarding the quality and generation of the seeds, leading to uncertainty about potato yields. The tradition of using potato seed tubers across generations also has a negative impact on tuber quality, with the inheritance of seeds from generation to generation potentially causing a decline in quality. Potato plants also become more vulnerable to pest and disease attacks during their growth. Weaknesses in seed selection and maintenance can result in decreased productivity and the health of potato plants.

The uncertain origin of seeds poses challenges in production risk control. Potato plants grown from seeds with unclear origins can complicate pest and disease management, as farmers may not be aware of the sanitation history and previous treatments of these seeds. Therefore, the use of potato seeds with less guaranteed quality and origin can actually be a factor in increasing production risks. This demands special attention in the selection and maintenance of seeds to ensure the sustainability of optimal production. This finding contradicts previous research by (Hidayati 2016).

The addition of P fertilizer significantly reduces the risk of potato production, indicating risk-decreasing input. This is because plants still need the availability of P elements. The use of P fertilizer (192 kg/ha) by potato farmers is still below the recommended dose of 270 kg/ha, and the results of the estimation of the frontier production function show that the addition of P fertilizer can significantly increase potato production. The addition of solid pesticides significantly reduces the risk of potato production, indicating risk-decreasing input. Estimates of his frontier production function show that the addition of solid pesticides can significantly reduce potato production, possibly because excessive use increases pest and disease attacks. This finding is in line with previous research which shows that fertilizers and pesticides are inputs that reduce risk (Guan and Wu 2009; Fauziyah 2010). The addition of TKLK significantly increases the risk of potato production. However, the results of the estimation of the frontier production function show that the addition of TKLK can increase production. This finding contradicts previous research by Suharyanto et al. (2015), which states that increasing the use of labor should reduce the risk of farm failure. It may be caused by TKLK's lack of responsibility for farming results and increased production costs. Previous research (Fariyanti, 2008; Tiedemann & Lohmann, 2013; Villano et al., 2005) states that labor input increases risk.

Estimation of the technical inefficiency function in the rainy season shows that N fertilizer, P fertilizer, and TKDK have a negative effect on the technical inefficiency of potato farming. In contrast, K fertilizer and TKLK have a positive effect. However, adding N fertilizer, P fertilizer, and TKDK by 1% can reduce technical inefficiency by 0.491%, 0.24%, and 0.461%, respectively, assuming other factors remain constant. On the other hand, K fertilizer and TKLK can increase technical inefficiency by 0.292% and 0.461%, respectively. Estimation of the technical inefficiency function in the dry season shows that land input, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid pesticides, and TKDK have a negative effect on the technical inefficiency of potato farming. Adding 1% of each input will reduce technical inefficiency by 0.308%, 0.268%, 0.125%, 0.065%, 0.131%, 0.114% and 0.124%, assuming other factors remain constant.

The application of nitrogen (N) and phosphorus (P) fertilizers significantly reduces technical inefficiency in potato production. Adding N and P fertilizers can decrease technical inefficiency as they are considered inputs that mitigate risk (risk-decreasing). The availability of nutrients in the soil plays a crucial role in the growth of potato plants, as indicated by estimates of the production risk function, which show that the addition of N and P fertilizers can significantly reduce production risk.

Despite farmers in the sample using an average of 96 kg/ha of N fertilizer and 192 kg/ha of P fertilizer, which is still below the recommended 150 kg/ha of N fertilizer and 200 kg/ha of P fertilizer, the actual addition of N and P fertilizers results in a significant decrease in potato production. Nitrogen deficiency can slow down growth as nitrogen is essential as an energy source in photosynthesis (Awur et al., 2009). Meanwhile, a lack of phosphorus fertilizer inhibits vegetative growth and potato tuber production. The results of estimating the variables of N and P fertilizers indicate a decrease in technical efficiency, contrary to Saptana's (2011) research, which showed that N and P fertilizers have a positive impact on technical inefficiency in the production of large red chili peppers.

The addition of Family Labor (TKDK) significantly reduces technical inefficiency on potato farming at a 10% significance level. The participation of family members in the workforce can contribute positively to technical efficiency. This is because the use of family labor is more flexible and can be adjusted to the needs of the crops, thereby reducing production costs and increasing productivity. Additionally, the use of family labor can also mitigate production risks as it does not involve additional costs for labor wages. Previous research has also indicated that labor has a negative impact on technical inefficiency (Fauziyah (2010); Saptana (2011).

The results of estimating the technical inefficiency function show that an increase in the use of Family-Owned Labor (TKLK) significantly increases technical inefficiency in potato farming at a 1% significance level, which is consistent with the findings of Hidayati (2016). This differs from the findings of Saptana (2011), which suggested that the use of Family-Owned Labor (TKLK) is considered a way to equalize and enhance efficiency in potato farming management.

Estimates of the technical inefficiency function during the dry season reveal that various inputs such as land area, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid pesticides, and Family Labor (TKDK) have a significant negative impact on the level of technical inefficiency in potato farming. Optimizing input use, particularly by increasing land area, can reduce technical inefficiency. Although expanding land area supports larger-scale operations and the potential for higher production yields, it also involves significant investments, increasing production risks due to price fluctuations and weather conditions. On average, farmers manage only 0.69 hectares for potato farming, as land is considered a risk-increasing input. Although there is potential for efficiency improvement through optimal input use, farmers are constrained by input limitations. The same holds true for the increased use of N, P, K fertilizers, solid pesticides, liquid pesticides, and Family Labor (TKDK), which would reduce technical inefficiency.

**Tabel 3**. Production risk preferences for each rainy season and dry season production input

| Input | Rain season | | | Dry season | | |
|---|---|---|---|---|---|---|
| | **θ** | **λ** | **Risk Preference** | **θ** | **λ** | **Risk Preference** |
| Land Size | -17,1580 | 58,9662 | Risk Averse | -24,8846 | 89,2511 | Risk Averse |
| Seeds | -18,7795 | 58,9663 | Risk Averse | -24,3546 | 89,2511 | Risk Averse |
| Fertilizer N | -17,1695 | 58,9662 | Risk Averse | -24,8811 | 89,2511 | Risk Averse |
| Fertilizer P | -17,2235 | 58,9692 | Risk Averse | -24,8577 | 89,2511 | Risk Averse |
| Fertilizer K | -17,1701 | 58,9692 | Risk Averse | -24,8807 | 89,2511 | Risk Averse |
| Pesticide Solid | -17,6997 | 58,9693 | Risk Averse | -24,6800 | 89,2511 | Risk Averse |
| Pesticide Liquid | -17,4215 | 58,9692 | Risk Averse | -24,7642 | 89,2511 | Risk Averse |
| TKDK | -17,4337 | 58,9692 | Risk Averse | -24,8135 | 89,2511 | Risk Averse |
| TKLK | -18,1496 | 58,9692 | Risk Averse | -24,2524 | 89,2512 | Risk Averse |

Source: Data Processed (2022)

Farmers have three risk preference categories: 1) risk-averse who always avoid risks; 2) risk-neutral, which is neutral towards risk; and 3) risk-takers who like risks. In this research, the risk preference analysis of farmers uses the Kumbhakar (2002) risk preference analysis model to produce the θ and λ values, which can be seen in Table 3. Based on the results of the analysis, the risk preferences of potato farmers for all production inputs (land, seeds, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid pesticides, TKDK, and TKLK) in the rainy season and dry season show that on average farmers has risk-averse tendencies. This finding is in line with other research, such as (Sinatria, 2021; Sasrido et al., 2022), which also found that the average risk preference of farmers is risk averse. Kumbhakar (2002), regarding salmon farmers in Norway, also supports this finding by showing that the overall preference for using Farmer input tends to be risk averse. Farmers tend to be reluctant to allocate inputs according to recommendations because they fear production risks (risk aversion), which, in the end, can lead to inefficient production (Ellis, 1993).

Farmers tend to be hesitant to allocate large amounts of production inputs to avoid potato production risks. The use of N, P, K fertilizers is still below recommendations due to limited fertilizer availability, lack of knowledge, and financial inability of farmers. In addition, farmers' reluctance to plant potatoes in too large of an area is associated with a high risk of costs and weather uncertainty. Overall, farmers tend to run inefficient farming practices due to fear of production risks and resource limitations.

## IV. Conclusion

This study aims to investigate the risk behavior in merangin potato farmers by using production function. The results shows that fertilizer, pesticide and labor factors are significantly influence on farmer risk function. Furthermore, results regarding risk analysis preferences of potato farmers for all production inputs (land, seeds, N fertilizer, P fertilizer, K fertilizer, solid pesticides, liquid specifics, TKDK, and TKLK) in the rainy season and dry season show that on average farmers have avoided risk propensity. The Merangin Regency Government should facilitate subsidies for certified fertilizers and pesticides, implicating the enhancement of production and their risk preferences. On the other hand, guarantees of fertilizer availability must also be ensured by policymakers. The farmers do not reduce the amount of fertilizer used, or the composition of fertilizer used does not match the recommended dosage.

## References

[1] Adekanmbi T, Wang X, Basheer S, Liu S, Yang A, Cheng H. 2023. Climate change impacts on global potato yields : a review. Environ. Resour. Clim. 3:2–22.doi:https://doi.org/10.1088/2752-5295/ad0e13

[2] Alam A, Ishida A, Esham M, Faridullah F. 2012. Tecnical efficiency and its determinan in production : Eviden Northern Areas in Gilgit-Baltistan Region of Pakistan. IJRMEC. 2(3):1–17.

[3] Andaregie A, Astatkie T. 2020. Determinants of technical efficiency of potato farmers and effects of constraints on potato production in Northern Ethiopia. Exp. Agric. 56(5):699–709.doi:10.1017/S0014479720000253.

[4] Asmara R, Widyawati W. 2019. Preferensi resiko petani dalam alokasi input usahatani jagung menggunakan model Just and Pope. J. Ekon. Pertan. dan Agribisnis. 3(2):449–459.doi:10.21776/ub.jepa.2019.003.02.20.

[5] Awur T, Kushartono EW, Setiyaningrum E. 2009. Aplikasi perbedaan komposisi N , P dan K pada budidaya eucheuma cottonii. 14(September):164–169.

[6] Dinas Tanaman Pangan Hortikultura. 2018. Revisi Rencana Strategis.

[7] Badan Ketahanan Pangan. 2020. Road Map Diversifikasi Pangan Lokal Sumber Karbohidrat Non Beras (2020-2024). Kementeri. Pertan. Indones.:1–49.

[8] Ellis F. 1993. An investigation of production risk, risk preferences and technical efficiency: evidence from rainfed lowland rice farms in the Philippines.

[9] Fang X, Xiang Z, Ma H, Wang F, Wang Q, Li P. 2023. Effect of N fertilizer dosage and base/topdressing ratio on potato growth characteristics and yield. Agronomy. 13(3).doi:10.3390/agronomy13030909.

[10] Fariyanti A. 2008. Perilaku ekonomi rumah tangga petani sayuran dalam menghadapi risiko produksi dan harga di Kecamatan Pangalengan Kabupaten Bandung. Ph.D. Dissertation, IPB University. Bogor. Jawa Barat. Agriculture Economics

[11] Fauziyah E. 2010. Pengaruh perilaku risiko produksi petani terhadap alokasi input usahatani tembakau: pendekatan fungsi produksi frontir stokastik. Ph.D. Dissertation, IPB University. Bogor. Jawa Barat. Agriculture Economics

[12] Guan Z, Wu F. 2009. Specification and estimation of heterogeneous risk preference. Di dalam: AgEcon Search. Vol. 1. Michigan State University. hlm. 11.

[13] Hidayati IN, Suryanto S. 2015. Pengaruh perubahan iklim terhadap produksi pertanian dan strategi adaptasi pada lahan rawan kekeringan [The effect of climate change on agricultural Production and adaptation strategies on drought prone land]. J. Ekon. Stud. Pembangunan. 16(1):42–52.

[14] Hidayati R. 2016. Pengaruh efisiensi teknis dan preferensi risiko petani terhadap penerapan usahatani kubis organik Di Kecamatan Baso Kabupaten Agam Sumatera Barat.. Thesis, IPB University. Bogor. Jawa Barat. Agriculture Economics

[15] Jennings SA, Koehler AK, Nicklin KJ, Deva C, Sait SM, Challinor AJ. 2020. Global potato yields increase under climate change with adaptation and CO2 fertilisation. Front. Sustain. Food Syst. 4(December).doi:10.3389/fsufs.2020.519324.

[16] Jufri M, Syaukat U, Fariyanti A. 2018. Pengaruh risiko produksi terhadap perilaku rumah tangga petani rumput laut d Kabupaten Wakatobi. Ekon. Pertnian dan Agribisnis. 2(5):443–453.

[17] Just RE, Pope RD. 1979. Production Function Estimation and Related Risk Considerations. Am. J. Agric. Econ. 61(2):276–284.doi:10.2307/1239732.

[18] Karimov A. 2013. Productive efficiency of potato and melon growing farms in uzbekistan: A two stage double bootstrap data envelopment analysis. Agric. 3(3):503–515.doi:10.3390/agriculture3030503.

[19] Karo B. 2018. Pengaruh pemberian pupuk fosfat dan sulfur terhadap pertumbuhan dan produksi tanaman kentang varietas granola dalam polibag. J. Agroteknosains. 1(2):111–116.doi:10.36764/ja.v1i2.36.

[20] Khan MA, Begum R, Nielsen R, Hoff A. 2021. Production risk, technical efficiency, and input use nexus: Lessons from Bangladesh aquaculture. J. World Aquac. Soc. 52(1):57–72.doi:10.1111/jwas.12767.

[21] Kumbhakar SC. 2002. Specification and estimation of production risk, risk preferences and technical efficiency. Am. J. Agric. Econ. 84(1):8–22.doi:10.1111/1467-8276.00239.

[22] Kumbhakar SC, Lovell CAK. 2000. Stochastic frontier analysis SFA. Int. Ser. Oper. Res. Manag. Sci. 157:197–231.doi:10.1007/978-1-4419-7961-2_7.

[23] Kune SJ, Muhaimin AW, Setiawan B. 2016. Analisis Efisiensi Teknis dan Alokatif Usahatani Jagung (Studi Kasus di Desa Bitefa Kecamatan Miomafo Timur Kabupaten Timor Tengah Utara). Agrimor. 1(01):3–6.doi:10.32938/ag.v1i01.23.

[24] Kurniati D. 2015. Perilaku petani terhadap risiko usahatani kedelai di Kecamatan Jawai Selatan Kabupaten Sambas. J. Soc. Econ. Agric. 4(April):32–36.

[25] Maganga A. 2012. Technical efficiency and its determinants in Irish potato production: Evidence from Dedza District, Central Malawi. African J. Agric. Res. 7(12):1794–1799.doi:10.5897/ajar11.1463.

[26] Nugraheni SS, Tinaprilla N, Rachmina D. 2022. Pengaruh penggunaan benih bersertifikat terhadap produksi dan efisiensi teknis usahatani kentang di Kecamatan Pangalengan. J. Agribisnis Indones. 10(2):389–401.doi:10.29244/jai.2022.10.2.389-401.

[27] Nurdin. 2011. Antisipasi Perubahan Iklim untuk Keberlanjutan Ketahanan Pangan. J. Dialog Kebijak. Publik. 4(November):21–28.

[28] Pamusu SS, Harianto H, Kuntjoro K, Winandi R. 2019. Dampak risiko produksi terhadap kesejahteraan rumah tangga petani bawang merah di Kabupaten Sigi. J. Ekon. Pertan. dan Agribisnis. 3(2):429–438.doi:10.21776/ub.jepa.2019.003.02.18.

[29] Purwantisari S, Hastuti RB. 2009. Antagonisme jamur patogen phytophthora infestans penyebab penyakit busuk daun dan umbi tanaman kentang dengan menggunakan Trichoderma spp. isolat lokal. Bioma. 11(1):8–9.

[30] Pusdatin. 2022. Buku Statistik Konsumsi 2022 Pusat data dan sistem informasi pertanian Sekretariat Jenderal Kementerian Pertanian 2022.

[31] Qomaria N. 2011. Analisis preferensi risiko dan efisiensi teknis usahatani talas di kota bogor. Thesis, IPB University. Bogor. Jawa Barat. Agriculture Economics.

[32] Rahayu S, Nadifah F, Prasetyaningsih Y. 2015. Jamur kontaminan pada umbi kentang. Biog. J. Ilm. Biol. 3(1):28–32.doi:10.24252/bio.v3i1.563.

[33] Raymundo R, Asseng S, Robertson R, Petsakos A, Hoogenboom G, Quiroz R, Hareau G, Wolf J. 2018. Climate change impact on global potato production. Eur. J. Agron. 100(October):87–98.doi:10.1016/j.eja.2017.11.008.

[34] Sahara D, Wulanjari ME, Triastono J. 2023. Optimasi penggunaan input produksi pada usahatani kentang di Dataran Tinggi Dieng , Jawa Tengah. 28(4):612–619.doi:10.18343/jipi.28.4.612.

[35] Saptana. 2011. Efisiensi Produksi Dan Perilaku Petani Terhadap Risiko Produktivitas Cabai Merah Di Propinsi Jawa Tengah. Ph.D. Dissertation, IPB University. Bogor. Jawa Barat. Agriculture Economics

[36] Saptana, Daryanto A, Daryanto HK, Kuntjoro. 2011. Efisiensi produksi komoditas cabai merah besar dan cabai merah keriting di Provinsi Jawa Tengah:Pendekatan fungsi produksi frontir stokastik. Forum Pascasarj. 34(3):173–184.

[37] Saptana N, Daryanto A, Daryanto HK, Kuntjoro N. 2010. Analisis efisiensi teknis produksi usahatani cabai merah besar dan perilaku petani dalam menghadapi risiko. J. Agro Ekon. 28(2):153–188.doi:10.21082/jae.v28n2.2010.153-188.

[38] Saptana, Sunarsih, Indraningsih S. 2006. Mewujudkan keunggulan komparatif menjadi keunggulan kompetitif melalui pengembangan kemitraan usaha hortikultura. Forum Penelit. Agro Ekon. 24(1):61–76.

[39] Sasrido M, Tanjug F, Mutiara VI. 2022. Analisis preferensi risiko petani pada usahatani Gambir di Kabupaten Pesisir Selatan. J. Agriuma. 4(2):78–87.doi:10.31289/agri.v4i2.7940.

[40] Sinatria T. 2021. Analisis efisiensi teknis usahatani cabai merah keriting dan preferensi risiko petani di Kabuaten Bogor. Thesis, IPB University. Bogor. Jawa Barat. Agriculture Economics.

[41] Suharyanto S, Rinaldy J, Ngurah Arya N. 2015. Analisis risiko produksi usahatani padi sawah. Agrar. J. Agribus. Rural Dev. Res. 1(2):70–77.doi:10.18196/agr.1210.

[42] Surmaini E, Runtunuwu E, Las I. 2017. Upaya sektor pertanian dalam menghadapi perubahan iklim. J. Penelit. 30(98):1–7.

[43] Syaukat Y. 2011. The impact of climate change on food production and security and its adaption program in Indonesia. ISSAAS. 17(1):40–51.

[44] Tajerin, Noor M. 2005. Analisis efisiensi teknis usaha budidya pembesaran ikan kerapu dalam keramba jaring apung di Perairan Teluk Lapung. 10(1):95–105.

[45] Tiedemann T, Lohmann UL. 2013. Production risk and technical efficiency in organic and conventional agriculture - The Case of Arable Farms in Germany. J. Agric. Econ. 64(1):73–96.doi:10.1111/j.1477-9552.2012.00364.x.

[46] 64(1):73–96.doi:10.1111/j.1477-9552.2012.00364.x.

[47] Tigre G, Heshmati A. 2023. Smallholder farmers' crop production and input risk analysis in rural Ethiopia. Appl. Econ. 55(6):671–689.doi:10.1080/00036846.2022.2094327.

[48] Villano et al. 2005. An Investigation of Production Risk , Risk Preferences and Technical Efficiency : Evidence from Rainfed Lowland Rice Farms in the Philippines by Renato A . Villano , Christopher J . O ' Donnell and George E . Battese. Agric. Resour. Econ.(February):14–16.

[49] van der Waals JE, Steyn JM, Franke AC, Haverkort AJ. 2016. Grower perceptions of biotic and abiotic risks of potato production in South Africa. Crop Prot. 84:44–55.doi:10.1016/j.cropro.2016.02.008.