INPUT ALLOCATION AND POTATO PRODUCTION ON SMALL-SCALE FARMING IN PEGUNUNGAN ARFAK REGENCY

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Abstract: Small-scale potato farming in the Arfak Mountains needs attention in allocating inputs for efficient farming. This study aims to describe the allocation of the use of potato farming inputs, analyze the factors that affect potato production, and analyze the level of technical efficiency of potato farming in the Arfak Mountains. Arfak Mountains Regency was chosen purposively as the research location. Data collection starts from December 2021 to February 2022. Sampling was done by snowball sampling with a sample of 140 respondents. The data used in this study is cross-section data which was analyzed using the Stochastic Frontier Cobb Douglas production function approach. The results showed that the average farmer in the Arfak Mountains controlled 0.07 hectares of land for potato farming, with a seed requirement of 22 kg per hectare. The factors that affect potato production are land, seeds, and female labor. The level of technical efficiency of potato farming is 73 percent. Improvements in farming management and extension assistance for good agricultural practices and the use of technology according to farmers' local wisdom need to be carried out to increase potato production and productivity.

Keywords: local knowledge, low input, potato, small-scale farming, technical efficiency

Abstrak: *Usahatani kentang skala kecil di Pegunungan Arfak perlu mendapat perhatian dalam pengalokasian input agar diperoleh usahatani yang efisien. Penelitian ini bertujuan mendeskripsikan alokasi penggunaan input usahatani kentang, menganalisis faktor-faktor yang memengaruhi produksi kentang, dan menganalisis tingkat efisiensi teknis usahatani kentang di Pegunungan Arfak. Kabupaten Pegunungan Arfak dipilih secara purposive sebagai lokasi penelitian. Pengambilan data dimulai Desember 2021 hingga Februari 2022. Pengambilan sampel dilakukan secara snowball sampling dengan jumlah sampel 140 responden. Data yang digunakan dalam penelitian ini adalah data cross section yang dianalisis menggunakan pendekatan fungsi produksi Stochastic Frontier Cobb-Douglas. Hasil penelitian menunjukkan rata-rata petani di Pegunungan Arfak menguasai lahan untuk usahatani kentang sebesar 0.07 hektar, kebutuhan bibit 22 kg per hektar. Faktor-faktor yang memengaruhi produksi kentang adalah lahan, bibit, dan tenaga kerja wanita. Tingkat efisiensi teknis usahatani kentang adalah 73 persen. Perbaikan manajemen usahatani dan pendampingan penyuluh untuk praktek pertanian yang baik serta penggunaan teknologi sesuai kearifan lokal petani perlu dilakukan untuk meningkatkan produksi dan produktivitas kentang.*

Kata kunci: *pengetahuan lokal, input rendah, kentang, usahatani skala kecil, efisiensi teknis*

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INTRODUCTION

Potato is one of the horticultural commodities that have great potential to be developed in Indonesia because it can be a source of income for the community and farmers, both small, medium, and large (Ali et al. 2020). Further, (Mulyono et al. 2018) said that the potential of potatoes as a source of carbohydrates and the provision of sustainable food to achieve resilience had made potatoes included in the superior national commodity and received attention in their development and cultivation.

Potato production from 2015 to 2019 tends to increase, but the rate of increase in production is relatively low, at 2.03 percent. Meanwhile, the average productivity of potatoes is 17.97 tons/ha. Although productivity tends to be high, the rate of increase in productivity is low compared to the production level. Therefore, it is necessary to increase productivity. This is because the productivity standard has not been achieved, which is 20 tons/ha (BPS, 2017-2020). Based on the results of the National Socio-Economic Survey in Quarter 1 of 2013-2018, potato consumption increased in 2013-2016 and decreased in 2017 and 2018 with the average level of potato consumption in Indonesia being 2.23 kg/capita/year or equivalent to 0.04 gram/capita/week and the average growth throughout 2014-2018 was 13.95 percent. The increase in consumption should also be accompanied by the fulfillment of consumption needs from domestic production so that imports can be reduced and the community's needs can be met (Arifin et al. 2021).

The potato-producing center in West Papua is the Arfak Mountains Regency. Based on the results of interviews, in the era of 2000s, in the Arfak Mountains, potatoes became one of the crops that could increase farmers' livelihoods and incomes because they gave high yields at harvest. Currently, potatoes are still the main food crop along with other sweet potato commodities, although the introduction of rice has begun to shift the role of tubers as a food source (Mulyadi, 2012), (Yuminarti et al. 2018). This is done because potatoes and other tuber crops can produce yields without intensive cultivation and only use low-production inputs (Yaku et al. 2019). Thus, potatoes need attention in their development to meet local and inter-regional food needs so that they are no longer dependent on inter-island products due to geographical conditions and relatively high transport costs. Data from the Central Bureau of Statistics of the Arfak Mountains and the Department of Food Crops and Horticulture of West Papua Province show that potato production in the Arfak Mountains during the period 2018-2020 continued to decline with an average of 47.49 tons. The decline in production indicates the low productivity of potatoes. Potato productivity in the Arfak Mountains for the last three years (2018-2020) tends to fluctuate with an average of 1.48 tons/hectare. This productivity is very low compared to potato productivity in Java, Sumatera, and North Sulawesi, where the average productivity ranges from 10-22 tons per/hectare (Central Bureau of Statistics, 2016-2020).

The potato farming system in the Arfak Mountains is still traditional on a small scale. The reason is that the average land use is less than 0.1 hectares, so farmers plant less. Second, the technology used is simple and has not been managed intensively by applying good cultivation techniques. Farmers are still practicing shifting agriculture using a slash-and-burn system. , simple equipment, and less responsive to innovation. However, farmers continue to pursue farming with traditional patterns because they are supported by socio-cultural values and the local knowledge of farmers (Mulyadi dan Iyai, 2016). This is an obstacle in farming activities because farmers prefer to implement farming activities based on hereditary experiences, such as not using fertilizers and drugs. The indication is farmers' ability in cultivation techniques, and the allocation of input use results in low production and productivity. Whereas the use of inputs plays an important role in producing production. (Esmael, 2017) wrote that low productivity was mainly due to the lack of superior potato varieties, the lack of certified potato seeds, and the managerial ability of farmers to manage potato farming. The low productivity of potatoes in the Arfak Mountains indicates the need to increase production efficiency to reach its potential. Widanage et al. 2022 stated that technical efficiency describes the maximum output level through the optimal allocation of resources. However, potatoes in the Arfak Mountains became a commercial product as a source of farmers' income (Yuminarti et al. 2018) even though farmers had to travel > 100 km in extreme geographical conditions to access the market.

Several studies related to small-scale potato production and technical efficiency have been carried out, such as by Nyagaka et al. 2010, Wassihun et al. 2019, Gulak and Obi-Egbedi, 2021, and Tolno et al. 2016. These analyses are applied to potato farming with

the application of cultivation techniques and good technology in areas with good access to markets to provide inputs and outputs. This distinguishes it from potato farming activities in the Arfak Mountains, where farmers with local knowledge grow potatoes in small quantities but still sell them to earn income even though market access is far away. Therefore, this study aims to describe the allocation of the use of potato farming inputs, analyze the factors that affect potato production, and analyze the level of technical efficiency of potato farming in the Arfak Mountains. The research results are expected to be the material for formulating agricultural policies, especially improving the performance of potato farming in areas with extensive but commercial farming characteristics.

METHODS

Arfak Mountains Regency was chosen as the research location because it is the center of potato farming in West Papua Province. Furthermore, three districts were selected, namely Hingk District, Anggi District, and Sururey District purposively with consideration of high production and potential for potato development with LQ > 1 (Sagrim et al. 2017). Data collection is carried out in December 2021-February 2022. The next stage is to determine the sample farmers using the snowball sampling method which is a non-probability sampling method when the total population is unknown (Johnson, 2014). This is true in the Arfak Mountains District, where obtaining a permanent list of farmers is difficult because the list of farmers owned by the Regional Agriculture Service is incomplete and not up-to-date, so sample selection from the list may result in bias (DiGaetano, 2013). Based on this technique, the researcher's initial process first identifies several members of the population (initial sample) based on criteria, namely farmers who are still farming potatoes from each district selected through the Village Head, Tribal Head, and the Department of Agriculture. Furthermore, the selected farmers will appoint or invite other friends to be used as samples, increasing the number of samples. The number of samples taken from the three districts is 140 respondents. The data used in this study were cross-sectional data at the household level who engaged in potato farming which was obtained through observation and open interviews using a questionnaire. Observations and interviews were conducted to obtain information about the socio-economic characteristics of farmers (age, gender, education level, and farming experience) and the characteristics of farmers' farming activities (land area, land status, use of seeds, use of labor, and production). The data obtained will then be tabulated and analyzed quantitatively and qualitatively. Based on the objectives, it will be explained descriptively related to the use of inputs according to the existing conditions of potato farming. Second, as was done by (Battese and Coelli, 1995), (Najjuma et al. 2016), (Dube et al. 2018), (Andaregie & Astatkie, 2020) who uses the Cobb-Douglas stochastic frontier production function to determine technical efficiency. This study uses the stochastic frontier Cobb-Douglas production function approach to analyze the factors that affect potato farming production and technical efficiency. Stochastic frontier analysis has implications for the choice of functional form. The stochastic frontier production function analysis can be used to measure and estimate the technical efficiency of potato farming from the input side and the factors that influence it. The Cobb-Douglas production function model is empirically proven to be relevant for research in the agricultural sector. The Cobb-Douglas production function model is as follows:

$$Y_i \; LnY_i = \beta 0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + e_i$$

where: Y_i is potato production, measured in units (kg), X_1 is area of potato farming (ha), X_2 is number of seeds used (kg), X_3 is number of male workers (HOK), X_4 is number of female workers (HOK), β_0 is intercept, β_i is vector of parameter to be observed, and e_i is residual.
Potato productivity in Arfak Mountains Regency tends to be low and fluctuates. This can be caused by internal factors such as the use of inputs (seeds, without fertilization, use of labor) production that is not appropriate so that efficiency is not achieved. External factors consist of social and ecological factors. The Arfak Mountains Regency has a topography of > 80 percent steep. The local wisdom adopted by the community in carrying out their farming can also affect the efficiency and productivity of potato farming. Thus, the sign of the expected parameter is $\beta 1, \beta 2, \beta 3, \beta 4 > 0$. The estimation of the production function uses the Frontier 4.1 program using the Maximum Likelihood Estimator (MLE) method.

RESULT

Use of Inputs and Production of Potato Farming

Farmers in the Arfak Mountains Regency generally apply traditional agriculture so that production inputs are limited and do not even use production inputs to preserve the environment for generations. For potato commodities, farmers do not use fertilizers and drugs in the production process because farmers carry out farming activities based on the experience of their parents and do not want to accept innovations on the grounds of crop failure. In this study, the production inputs used are land, seeds, and labor.

Land tenure

One of the production inputs that are the basis for farming is the area of land cultivated by farmers, which is the most important natural resource in farming activities. Based on the results of surveys and interviews with farmers, the average area of land cultivated by potato farmers in the Arfak Mountains Regency is 0.07 hectares. Land tenure by farmers is very narrow (between 0.05 - 0.1 hectares), with distribution in each sample district. Hingk District farmers control 0.09 hectares of land, Anggi District farmers control 0.056 hectares of land, and Sururey District farmers' average land tenure is 0.052 hectares. This can be one of the obstacles in increasing production because the area or narrowness of the business area has implications for the high and low agricultural production produced. (Taiy et al. 2017) write that land size is positively correlated with productivity. Farmers with relatively large holdings are expected to benefit from economies of scale. The same study by (Tolno et al. 2016) found that most farmers in Guinea cultivate potatoes for less than 1 hectare with an average of 0.89 hectares. Increasing farm size can increase production if the land is used effectively, requiring appropriate agricultural practices and inputs. In line with this, (Nyagaka et al. 2010) also wrote that Kenyan farmers allocated 0.34 hectares of land for potato farming on average.

The agricultural land cultivated by farmers for potatoes in Hingk and Anggi Districts is divided into yard and garden land. This is done because the existing yards are relatively limited, so farmers open other business areas which are located quite far from their homes with 1-2 hours on foot. Farmland owned by farmers is land with communal ownership status. So, it is not only owned by a farmer but also belongs to the farmer and his relatives. The average garden area cleared is > 1 hectare. When the land is opened for cultivation, each farmer will cultivate according to the area to be planted so that the status of the previously communal land (farmers and relatives) belongs to the farmer. The type of land ownership determines the type of innovation and development that farmers will carry out on their land (Taiy et al. 2017). So, farmers will carry out permanent long-term farming activities on their land. Sururey District farmers only grow potatoes in their gardens because the land is used specifically for other horticultural crops such as carrots, leeks, and shallots. In contrast to the gardens in the Hingk and Anggi districts, which are located at the foot of the mountain with an average slope of > 30 percent, the gardens in the Sururey District are located on flat slopes, not far from the house.

Seeds

The results of farmer interviews provide information that potato farmers in the Arfak Mountains use seeds obtained from previous harvests. Many of the seeds planted by farmers are granola varieties, but the farmers themselves do not know the varieties of seeds used because they have been used for more than four planting periods. Seedlings obtained from potato cultivation for generations and with unclear varieties and their derivatives will provide more tubers but are economically unprofitable because the tubers are small, causing a decrease in tuber quality and sensitivity to pests and plant growth diseases (Syafri et al. 2005). Potato seeds are traditionally stored in “noken” bags and hung on the outside wall of the house. According to farmers, this method of storage is relatively easy, but the quality of the seeds is low because stored seeds can be contaminated with various diseases that are transmitted through tubers for generations. This can result in decreased productivity. Although potato is a perishable commodity, they can be a climate change adaptation strategy with good storage because it ensures a sustainable supply of potatoes and seeds (Taiy et al. 2017). Furthermore (Sayaka dan Hestina, 2011) stated that the use of certified seeds could increase farmers’ yields and profits compared to using uncertified seeds. Farmers in Hingk District and Sururey District have never obtained potato seeds with quality standards because obtaining these seeds requires a large amount of capital because they are relatively expensive. While some farmers in Anggi District who are members of

farmer groups sometimes receive seed assistance from the Department of Agriculture every year, they are not used by farmers because there is no assistance from extension workers. Farmers will apply technology or innovation if there is continuous assistance from extension workers or related agencies. The same thing was written by (Tolno et al. 2016) that access to superior seeds is an obstacle to production for potato farmers in Guinea, so farmers also use seeds from previous harvests and from informal systems or organizations.

Based on the survey results for the last planting season, the need for potato seeds for the next planting season is not too much because it is in accordance with the size of the land used. The preparation of seeds carried out by farmers is approximately 2-5 nokens with varying weights ranging from 5 kg - 20 kg per noken. The average need for potato seeds per growing season is 22 kg per hectare . When compared between districts, the need for seeds in Hingk District is higher for each planting season, which is 27 kg per hectare. This is because the land used to grow potatoes is larger than in Anggi District and Sururey District, where the seed requirements are only 12 kg per hectare and 17 kg per hectare, respectively. The need for seeds in the Arfak Mountains is very low when compared to the small-scale potato farming conducted by (Nyagaka et al. 2010), (Tiruneh et al. 2017), (Tolno et al. 2016) and (Maryanto et al. 2018) which need for seeds is between 500 - 2200 kg per hectare. The need for seeds is low because the area of land used to grow potatoes has also been getting smaller in the last year. Farmers are tired of planting potatoes because they are always attacked by diseases when the plants are one month old and it happens again and again. There has been no action from the relevant agencies and the farmers themselves are reluctant to report this incident. The recommended potato seed requirement issued by the Research Institute for Vegetable Crops (Balitsa) for an area of one hectare is around 1,200 kg (with tuber size of 30 g/knol) (Setiawati et al. 2007).

Labor

The labor used in potato farming comes from workers in the family. Labor outside the family is only used when clearing land, planting, and harvesting when labor is unavailable. The number of outside workers used depends on the area of land being managed. The external workers used are those who still have kinship/family relations or siblings with farmers who want to clear land (Tim Unipa, 2015). In further analysis, the workforce is divided into male workers (TKP) and female workers (TKW). This division is based on the consideration that there are different roles between TKP and TKW in farming activities in the Arfak Mountains. Male workers are more involved when land clearing activities include tree felling, clearing fallen trees, making fences, and loosening the soil. Women workers play a role from land clearing to marketing activities. The workload of women is greater than that of men. The average workload is calculated based on the number of working days (HOK) equivalent to 8 hours of work in one day. The amount of men's work per planting season for potato farming is 36.74 HOK, while the women's work is 48.53 HOK. This result is quite different from the research conducted by (Nyagaka et al. 2010) and (Tiruneh et al. 2017), that the average workload for potato farming is between 150 - 300 HOK.

Overall, women's total workload is higher than men's in each study area. The largest employment in Hingk District was 37.89 percent for land clearing activities. This is because the land-clearing process carried out using the slash-and-burn system requires more labor and takes longer. This was followed by marketing activities of 25.02 percent. (Dube et al. 2018) wrote that the use of labor for potato farming in Ethiopia is for land clearing, weeding, and harvesting activities. Unlike in Anggi and Sururey Districts, marketing activities require more work than other activities. The time required for marketing activities is approximately one week, depending on the products produced. The least amount of work is for planting and post-harvest activities. Planting usually takes 1-2 working days and can be done by the farmer's own family. Likewise, the time for post-harvest activities is carried out 1-2 days. For maintenance, farmers do not do it every day, especially for gardens located at the foot of the mountain; except for those in their yards, they usually only control whether there are pests and diseases.

Production

Based on the survey results obtained data the average potato production in Arfak Mountains Regency based on research data is 150 kg or the equivalent of 0.15 tons. The low production is due to the reduced area of business land and many potato plants that fail to grow due to late blight. Sururey District has the lowest potato production at only 106 kg, followed by Anggi District at 116 kg. Failure to grow potato plants has occurred

for about one year. This reduces the motivation of farmers to plant potatoes in large land areas due to trauma to plants that rot when they are one month old. Meanwhile, the average potato production in Hingk District reaches 180 kg. There are still many potato farmers in Hingk District, and potatoes are currently the main crop grown by farmers. However, traditional cultivation techniques left to nature make production low. The average production in the Arfak Mountains is very low compared to potato production in other developing countries, which is between 2-17 tons (Andaregie & Astatkie, 2020), (Wassihun et al. 2019), (Tiruneh et al. 2017). When viewed from the productivity point of view, the average productivity of potatoes in the Arfak Mountains is very low, only 0.24 kg/ha, and this result is lower than the average potato productivity for the last three years (2018-2020), which is 1.48 kg/ha.

Factors Affecting Potato Production

In accordance with what has been mentioned in the research method, the Stochastic Frontier Cobb Douglas production function model with Maximum Likelihood Estimator (MLE) estimation is used in this study. Referring to equation 1 to estimate the overall parameters (βi) and intercept (β0) and the gamma value to estimate how much influence the variances v_i and u_i have in determining the production model. The results of the estimation of the production function model using the MLE method are presented in Table 1.

The estimation results in Table 1 show that the value of the Generalized-Likelihood Ratio (LR) test (15.60) is greater than the value of the palm table code at the level of = 5 percent (2.706), meaning that it is statistically significant. This indicates that the LR test accepts H1 that in this model, there is an effect or case of inefficiency. This means that almost all variations in the output of the frontier production function can be considered as the achievement of technical efficiency related to managerial issues in farm management. So, the LR test explains the existence of farmers' technical efficiency and inefficiency in the potato production process. In other words, potato farming activities are influenced by technical efficiency.

The sigma-squared parameter value (σ2) shows the total variance of the two components, namely the inefficiency effect (u_i) and the noise effect (v_i). The calculation results obtained that the value of 2 is 0.229, significantly different at the level of = 1 percent, so it can be concluded that the model used is correct and the errors u_i and v_i normally spread according to the desired assumptions. The calculation results can be seen that the estimated coefficient of gamma (γ) of 0.884 is not significantly different from zero or significantly affects the level of = 1 percent. This figure shows that 88.4 percent of the variation in yield among the sample farmers is due to differences in technical efficiency, and the remaining 11.6 percent is due to external influences such as climate, pest and disease attacks, and modeling errors. This shows that the effect of technical inefficiency is a significant factor in the variability of output.

Table 1. Estimating the production function of potato farming in Arfak Mountains Regency, 2022

Variable	Combined	Hingk	Anggi	Sururey
	Estimated parameters	Estimated parameters	Estimated parameters	Estimated parameters
Constant	3.992	3.578	1.823	2.934
Land area (X1)	0.317**	0.316**	0.181	0.413**
Seed (X2)	0.520**	0.483**	0.910**	0.213**
Male workforce (X3)	-0.010	0.141*	0.148	-0.070
Female workforce (X4)	0.182*	0.157*	0.374*	0.967**
Sigma-squared (σ2)	0.229	0.079	0.621	0.187
Gamma (γ)	0.884	0.884	0.999	0.999
LR Test	15.61	3.58	10.81	16.78

Information: * significant at level = 5% (0.05); ** significant at level = 1% (0.01)

Based on table 1, the three presumed parameters have been signed in accordance with expectations, namely land area, seeds, and female labor, where the parameter (β) is positive. Variables that affect the level of = 1 percent are land area and seeds, while female workers influence the level of = 5 percent. Meanwhile, male workers have a negative sign and have no effect on production. The value of the regression coefficient (β) in the production function of Cobb-Douglas shows the value of elasticity. If farmers aim to maximize profits, then farmers must produce in a rational area, i.e., when the elasticity is between zero and one (Debertin, 1986). The sum of the elasticity values of the production factors results in the Return to Scale (RTS) value, namely the business's economic scale, which is the production response to changes in the input used. The calculation results show that the RTS value in the production function is 1.009, which is greater than 1 (RTS>1). This means that farming is in the Increasing Return to Scale (IRTS) condition that increasing the use of input combinations will increase production yields by a percentage greater than the percentage increase in inputs. When viewed between districts, Hingk and Anggi also have RTS values > 1, which are 1,094 and 1,586, respectively. Meanwhile, in Sururey District, the RTS value is < 1 (0.89). This means that the farm is in a Decreasing Return to Scale (DRTS) condition that increases the use of a combination of inputs will increase production yields by a smaller percentage than the percentage increase in inputs.

The elasticity of the frontier production function for inputs that have a significant effect on potato production is land area, number of seeds and female labor with values of 0.317, 0.520, and 0.182, respectively. If each of these inputs is added by 10 percent, ceteris paribus, it will increase potato production by 3.17 percent, 5.20 percent, and 18.2 percent, respectively. This figure shows that potato production is very responsive to land area, seeds, and female labor. Especially for land, it becomes important in increasing production considering that the productivity level of potatoes is still very low. Farmers who allocate more land for potatoes will increase production if done with good management to increase farmers' income (Tolno et al. 2016). (Bukul, 2018) wrote that access to fertile land should encourage farmers to increase potato production. The results showed that farmers' land tenure in the Arfak Mountains for potato farming was relatively small (less than 0.5 hectares), while there was sufficient land available. The ongoing development in the Arfak Mountains has resulted in a lot of potato land being converted to non-agricultural use. In contrast to Hingk District and Sururey District, where land is very influential in increasing production, in Anggi District, although the sign is positive, land does not significantly increase production. This means that land is no longer the main input in production. Anggi District, as the capital of the Arfak Mountains Regency, made many changes due to development. Land conversion is visible, where land that used to be planted with potatoes has been turned into buildings or left unplanted. In addition to these factors, the saturation of farmers growing potatoes appears when the plant does not provide optimal results. Then farmers will switch to other crops on potato fields. In this district, there are not many farmers growing potatoes. Therefore, efforts to increase productivity need to be emphasized by policymakers. The results of research that produce land area significantly affect production as carried out by (Widayati, 2017), (Maryanto et al. 2018), and (Tristya et al. 2018)

The variable number of seeds is the most responsive production factor, with the first elasticity (0.520) followed by land and female labor. The seed variety that farmers use is granola, even though it is obtained from previous harvests and has been more than four generations of planting period. In this case, the seed becomes a limiting factor in potato production. Farmers do not buy potato seeds because they are expensive, especially certified ones. Apart from the price factor, farmers are not brave enough to try new seeds for fear of failure, or the plants will not grow. Farmers are more confident in the seeds produced from generation to generation. The same is true for Kenyan farmers in potato production, where there is no access to quality and certified potato seeds and a structured seed supply and distribution system. High prices and not being available on time are obstacles (Taiy et al. 2017). The highest seed elasticity value is in Anggi District (0.91) because farmers in Anggi often receive assistance from the government, there are farmer groups, and assistance from extension workers. This is what makes it different from other districts. Farmers who are members of farmer groups often receive seed assistance once or twice a year so that potato plants become better, as indicated by large production. Farmers who use superior seeds will increase their output and market surplus (Tolno et al. 2016). (Tristya et al. 2018) stated that seeds play an important role in optimizing production.

In contrast to the male workforce, the opposite result is shown in the female workforce variable, which generally gives a significant effect on the level of significance (α) = 5 percent. The sign of a positive parameter with an elasticity value of 0.182. This value means a 10 percent increase in labor will increase potato production by 18.2 percent. The role of female workers who have the most influence on production is in the District of Sururey with an elasticity value of 0.967 and is significant at the level of = 1 percent. This means that a 10 percent increase in labor will increase potato production by 96.7 percent. This indicates that women are most involved in farming activities. The survey results show the role of women in farming is greater (51.65 percent), starting from land processing activities to marketing. The male profession with the main job as a civil servant or other occupations causes the role of men in farming to be small. Especially in marketing activities for Sururey and Anggi Districts, it is the women's job. In contrast to Olagunju (2007), the role of male workers dominates farming activities. Female workers are more involved in planting, fertilizing, maintaining, and marketing activities.

Technical Efficiency

Technical efficiency is analyzed by using the stochastic frontier production function model. The distribution of the technical efficiency of potato farming can be seen in Table 2, obtained from the analysis of the stochastic frontier production function.

The level of technical efficiency shows that most potato farmers produce at technical efficiency between 70 – 90 percent. The least efficient farmers only achieve a technical efficiency level of 23 percent, and the most efficient farmers produce at a technical efficiency level of 95 percent. This distribution is not different when compared to the results of research by (Nyagaka et al. 2010), (Wassihun et al. 2019), and (Andaregie & Astatkie, 2020), which found that inefficient potato farmers had an estimated technical efficiency value of between 20-30 percent. The average value of technical efficiency in the Arfak Mountains is 73 percent. This means that farmers can obtain 73 percent of the potential output at the given input level. On average, farmers are relatively efficient, but about 27 percent of the output obtained by farmers is lost due to inefficiency in production. This means that farmers could achieve frontier output of up to 27 percent with the adoption of better technology and management techniques (Gulak and Obi-Egbedi, 2021), (Nyagaka et al. 2010), (Dube et al. 2018). Thus, farmers with a low level of technical efficiency can have the opportunity to increase production according to farmers who have a high level of technical efficiency with current technology (Asmara et al. 2016). The results of this study are in line with the findings (Nyagaka et al. 2010), (Wassihun et al. 2019), (Andaregie & Astatkie, 2020), (Rizkiyah et al. 2014), and (Maryanto et al. 2018) which stated that the average technical efficiency of potatoes is between 50-85 percent.

Managerial Implications

Small-scale potato farming implemented by local farmers determines the level of production and productivity. The local hereditary knowledge held by farmers in cultivating potatoes causes farmers to be unable to allocate the use of inputs to achieve efficient farming. The existing situation of potato farming in the Arfak Mountains illustrates the inability of farmers to allocate inputs even though the analysis results show efficient farming. The capacity of farmers must be increased with assistance from related parties (government and private sector) to increase farmers' managerial capacity.

Table 2. Distribution of respondent farmers based on the level of technical efficiency of potato farming in Arfak Mountains Regency, 2022

Technical Efficiency Rate (%)	Number of Respondents (Persons)	Percentage (%)
< 0.70	49	35.00
0.70 - 0.90	82	58.57
> 0.90	9	6.43
Total	140	100.00
Maximum	0.95	
Minimum	0.23	
Avarage	0.73	

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Farmers in the Arfak Mountains control 0.07 hectares of land for potato farming, use of 22 kg of seeds per hectare, and the workload of men per growing season is 36.74 HOK and female workers 48.53 HOK. The average potato production is 150 kg with a productivity level of 0.24 kg/ha. Factors that affect production are land, seeds, and female labor. The elasticity value generated in the production function is 1.009, namely in the Increasing Return to Scale condition. The results also show variation in technical efficiency among potato farmers, with an average technical efficiency level of 73 percent, implying there is potential to increase efficiency by 27 percent.

Recommendations

Intensive assistance from extension workers needs to be done, especially for good agricultural practices, the use of technology according to the local wisdom of local farmers, and the formation of farmer groups. Further research can consider aspects of commercialization to increase productivity and efficiency as well as the sustainability of small-scale potato farming in the Arfak Mountains.

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