Journal Agrisep: Kajian Sosial Ekonomi dan Agribisnis. 23 (02): 667-684 (2024)

AGRISEP: Journal of Agricultural Soci-Economics and Agribusiness Studies

https://ejournal.unib.ac.id/agrisep/index

DOI: 10.31186/jagrisep.23.02.667-684

ECONOMIC EFFICIENCY OF PINEAPPLE FARMING USING THE STOCHASTIC FRONTIER APPROACH

Adhiana[1)*]; Rita Ariani[2)]; Ade Firmansyah Tanjung[3)]

[1),2),3)] *Agribusiness Study Program, Faculty Of Agriculture, Malikussaleh University, Aceh, Indonesia*

* Corresponding Author: adhiana@unimal.ac.id

ABSTRACT

Central Aceh Regency is the province's largest pineapple producer. However, pineapple farming is facing the problem of low pineapple productivity and input use efficiency. The research aims to analyze the factors that influence the level of technical efficiency and the allocative and economic efficiency of pineapple farming in Pegasing District, Central Aceh Regency. The sampling process employs the stratified random sampling method. The total sample consisted of 62 respondents. The stochastic frontier is used. The research revealed that the production factor of land area, with a variable coefficient value of 0.0312, seeds with a variable coefficient value of seeds of 1.0152, and pesticides with a coefficient value of 5.6239, significantly influenced pineapple farming production in Pegasing District. Conversely, the labor factor, with a coefficient value of 0.0408, and fertilizer, with a coefficient value of 0.1198, had an insignificant effect. The use of inputs in pineapple farming has reached technical efficiency values, but there are still opportunities to increase optimally. However, neither allocatively nor economically have we achieved efficiency. The technical efficiency value for pineapple farmers was 0.80, the allocative efficiency value reached 0.427, and the economic efficiency was 0.351. Farmers, as actors in farming activities, need to pay attention to the use of the right combination of inputs; economic efficiency will be obtained from the use of production factors so that pineapple farmers' income will increase.

Keywords: Allocative, Economy, Input, Pineapple, Technical Efficiency

* Submitted: June 20, 2024
Accepted: September 27, 2024

***Cite as*:**
Adhiana., Ariani., R., & Tanjung, A. F. (2024). Economic Efficiency Of Pineapple Farming Using The Stochastic Frontier Approach. Jurnal AGRISEP: Kajian Masalah Sosial Ekonomi Pertanian Dan Agribisnis, 23(02), 667-684. https://doi.org/10.31186/jagrisep.23.02.667-684.

INTRODUCTION

Aceh Province is in 23rd place in Indonesia in pineapple production, with a large amount of output in Gayo Luas Regency and Central Aceh Regency. Specifically, the Pegasing sub-district area in Central Aceh Regency is renowned for its main product. This Pegasing pineapple garnered recognition as a superior pineapple fruit during the National KTNA (Top Fisherman Farmer Contact) event in Banda Aceh city in 2017. Production in 2019 reached 153,790 kg/year, but there was a decrease in production in 2021 to reach 73,756 kg/year with a temporary increase in land area (BPS, 2022). The challenges, especially for smallholders, are that efficiency is still relatively low and inefficient at the farmer level, there are still many farmers who waste money in carrying out agricultural activities, then added to limited equipment with more modern technology, easy access to credit and land ownership, limited farmer capital, the level of pest and disease attacks, the use of less than optimal fertilizers and pesticides, low selling prices during the main harvest, and an inefficient marketing chain that still depends on other parties.

When viewed more specifically about challenges and obstacles in general, the problems faced by pineapple farmers in Pegasing Sub-district are also in line with the general issues that are still a concern and are still the most notable problems of declining productivity performance at the farm level, such as poor cultivation management, pests and diseases, and relatively low levels of efficiency. Increasing declining production can still be done with various alternative efforts to solve the problem, if possible, by increasing the land area. However, alternative strategies like this will be difficult to implement because the agricultural sector is also still facing challenges in increasing the conversion of agricultural land. We can apply alternative methods, such as developing and adopting new technologies and utilizing available production input or output resources more efficiently. The increase in the harvested area should have been in line with the rise in production in that year, but the opposite happened, there was a decrease in production in that year, which was caused by many possible factors, both in terms of the production process, the availability of production inputs, the increase in production input prices, and others.

Plant productivity strongly correlates with the efficiency of using land inputs, labor, seeds, fertilizers, and pesticides, and the underutilization of human resources prevents production from keeping pace with the expansion of land area (Lubis et al., 2016). The utilization of land inputs, labor, seeds, fertilizers, pesticides, and the quality of human resources has not reached its maximum efficiency. Efficiency is the comparison of output and input in a production process. Yotopoulos & Lau (1973) suggests that efficiency is a concept regarding achieving output with optimal use of resources and categorizes three types of efficiency: technical, price, and economic efficiency.

Economic efficiency result from a combination of two types of efficiency, namely technical and price (Yotopoulos & Lau, 1973). Efficiency promotes an increase in optimal production, reduces production costs, and boosts farmer income. The level of technical efficiency can be influenced by several factors such as land area, use of labor, seeds, fertilizers, and pesticides, and the managerial ability of farmers originating from the farmers themselves related to internal factors such as socio-economic and institutional factors, including age, level of formal education, informal education, farming experience, participation in a farmer group, interaction with extension workers, access to sources of farming financing, and so on (Witharana et al., 2007). Coelli & Rao (1998) also stated that technical efficiency can calculate the production achieved by using a certain amount of input.

Central Aceh Regency's low productivity in pineapple farming is believed to be due to suboptimal input management efficiency and allocation. (Adhiana & Riani, 2019) asserted that an efficiency indicator is the ability to generate multiple outputs by combining specific inputs at a low cost, all while maintaining production levels. Improvement of the efficiency system through the results of the stochastic frontier analysis approach is an effort to improve the performance of pineapple production produced by farmers in Pegasing District. The relatively low-efficiency level likely causes the decline in production, so it becomes the central focus seen from the production side, as well as technical efficiency, allocative efficiency, and economic efficiency simultaneously. Efficiency will not only encourage optimal production, but it will also reduce production costs and increase farmers' income. Therefore, this study uses the parametric approach of stochastic frontier analysis to answer the objectives and problems in the study. The study's objectives are to analyze the factors that influence the level of technical efficiency of pineapple farming in Pegasing District and to analyze the level of allocative and economic efficiency of pineapple farming in Pegasing District. The alternative solution of increasing the area to solve the problem of declining production at the farmer level is not possible, so simple efforts can be made to achieve efficiency from the production side, technical efficiency, allocative efficiency, and economic efficiency simultaneously.

The novelty of this research is the use of the stochastic frontier analysis method approach for economic efficiency research at the research location. Previously, this method had yet to be utilized to analyze pineapple farming efficiency. The stochastic frontier analysis method approach provides an answer to the issue of the inconsistency between the increase in land area and the amount of production and finds the causes of the problems that have the greatest influence on efficiency. The research results will contribute in the form of information to parties who need planning steps on how to solve the problem of pineapple farming efficiency.

RESEARCH METHOD

This study employs direct observation techniques to collect primary and secondary data at the location by conducting interviews and distributing questionnaires to farmers. For the primary data collection process, interviews and questionnaires were conducted for 5 months to obtain the necessary data, such as general characteristics of respondents, ownership of land area, technical methods of cultivation, production, and other data, to process data for farming efficiency analysis. Then, the search for information about the factors that cause or constraints that cause inefficient farming by farmers. The research survey team, and the farm owners actively established communication during the research process so that the interview activities ran smoothly.

The process of collecting primary data was carried out directly with pineapple farm owners, as well as direct observation of farmers' fields. This research was carried out in Pegasing District, Central Aceh Regency, and the location was determined deliberately because Pegasing District is the largest pineapple producer in Aceh. The research was conducted from November to March 2023. The population was all pineapple farmers in Pegasing District, Central Aceh Regency. The beginning of the process of determining the size of the sample size with the Slovin formula calculation, after which the process of sampling techniques with stratified random sampling of the sample size that has been determined amounted to 62 farmers. They conducted a grouping of farmers based on the determined land area limit. This sampling technique was chosen by considering several reasons, namely the distribution of respondents in the research location area, which is widely spread with different land area ownership, so the need for comprehensive data diversity in several villages in Pegasing Subdistrict, this research focuses on pineapple farmers and farm owners spread over 4 villages in Pegasing Subdistrict. Sampling was carried out using stratified random sampling based on the age of the pineapple plants that had been produced, namely over 24 months, after which farmers were grouped based on land area with a range of land area scales, namely <0.5 ha and 0.5-1 ha, resulting in 62 farmers spread across four predetermined villages. Using two types of data, primary and secondary data. Primary data was obtained through direct interviews with pineapple farmers, including land area, number of seeds, labor, amount of fertilizer, and pesticides. Challenges faced during the interview process and distribution of questionnaires, such as the difficulty of holding discussion meetings with farmers, because farmers also have many activities and work every day and the research location is far away, plus the farmers' education is still low so it is challenging to hold scientific discussions. The research survey team's difficulties were overcome through building communication with village officials, community leaders, and extension workers in the village. The research survey team also actively sought information by entering into discussion forums with farmer groups and extension workers in the village. With this approach, the research survey process can run smoothly.

Secondary data is obtained through literature reviews, production data, and research location description data. For literature review, such as review of related research journals and search for theoretical basis from books. Farmers provide the production data directly. The process of secondary data collection was carried out for 5 months, the research team actively visited the library to conduct library and literature studies with reference criteria or references relevant to the research to strengthen the theoretical basis and opinions in the research. The research survey team also actively visits the relevant agencies to ensure that the process of collecting data or documents needed for the research runs smoothly. The data is processed using the following analytical tools:

1. Estimating Technical Efficiency

   Factors influencing technical efficiency can be analyzed using the stochastic frontier production function. Technical efficiency is seen by comparing the deviation level of a farming business operating with the Frontier's proper production function (Kumbhakar, 2003). Data processing was done with the help of SPSS. To measure the level of technical efficiency, it was analyzed using a parametric approach, namely stochastic frontier analysis (SFA), through the use of the Cobb-Douglas frontier production function, which refers to the frontier approach, which requires the form of equations to explain the relationship between inputs, outputs, and environmental factors. If the pineapple farming business reaches a point that aligns with the frontier production function, it indicates technical efficiency. If the frontier production function is known, then the inefficiency factors can also be seen (Coelli & Rao, 1996; Aigner et al., 1977). The Frontier production function utilized is as follows:

   $$Ln\mathrm{Y} = \beta_0 + \beta_1 LnLh + \beta_2 LnBt + \beta_3 LnTk + \beta_4 LnPk + \beta_5 LnPs + V_i - U_i$$

   Note: Y= *Outputs* (Pineapple Production), Lh = Area of pineapple plantations, Bt = pineapple seed, Tk = Labor, PK = Fertilizer, Ps = Pesticides, β0 = Constant, β1– β5 = Estimated parameters, and Vi– Ui = error term.

2. Allocative and Economic Efficiency

Economic efficiency can be achieved if the increase in the marginal value of production factors is equal to the marginal sacrifice cost. Economic efficiency is obtained from the combination of technical efficiency and allocative efficiency. Allocative efficiency is the ability to produce at a certain output level using a ratio of inputs at minimum cost. Technical efficiency is the production process using a combination of inputs to produce maximum output. Allocative and economic efficiency can be quantified by deriving the dual cost function from a homogeneous Cob-Douglas production function (Debertin, 1986). Assuming that the Cob-Douglas production function uses two inputs, it is as follows:

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} e^{\mu}$$

The input cost function is as follows:

$$C = P_1X_1 + P_2X_2$$

The form of the dual cost function can be derived using cost minimization assumptions with the constraint Y = Y_0. According to (Yotopoulos & Lau, 1973). To obtain the dual function, the expansion path value must be obtained, which can be obtained with the Lagrange function as follows:

$$C_i = k \prod_j^b =_1 P_{xjiaj.Y0r}$$

Finally the cost function in this research can be derived as follows:

$$\ln C = \ln K + \alpha_1 \ln P_1 + \alpha_2 \ln P_2 + \alpha_3 \ln P_3 + \alpha_4 \ln P_4 + \alpha_5 \ln P_5 + r \ln Y_0$$

Based on the approach found by Kopp & Diewert (1982) allocative efficiency is calculated through the total cost ratio using the following equation.

$$AE = \frac{P_j X_c}{P_i . X_b}$$

Economic efficiency result from multiplying the technical efficiency value with price efficiency with all input factor usage. The efficiency of pineapple farming can be stated as follows:

$$EE = ET \times EA$$

RESULT AND DISCUSSION

General Description Of The Location And Research Respondents

Pegasing District is one of the districts in Central Aceh Regency. Its boundaries from the north, south, east, and west are Bies District to the north, Lut Tawar District to the south, Bebesen District to the east, and Jagong Jeget District to the west. The geographical conditions of Pegasing District are located at $40^0$50'14.42" - $40^0$59'89" LU and $96.82^0$81'41" BT. Pegasing District has an area of 169.83 km^2.

General Description of Respondent Characteristics

Farmer characteristics influence various aspects of pineapple cultivation, starting with input selection, cultivation techniques, fertilizer use ratios, and different management and decision-making. The following is data on farmer characteristics based on age, farming experience, and number of dependents in Pegasing District.

The age of farmers is a key factor that influences their performance in pineapple cultivation. Farmers in their productive age tend to be more optimal in cultivating pineapple plants. Here is the data on farmer characteristics based on age, highlighting the engaging role of age in pineapple farming.

Table 1. Age Level of Pineapple Farmers in Pegasing District

Age Level (Years)	Farmers number (Person)	Percentage (%)
0-14	0	0
15-64	62	100
> 65	0	0
Total	62	100

Source: Primary Data Processed, 2023

Based on age characteristics, the age range of farmers is between 15 - 64 because the average farmer who was a respondent to the research was 42 years old, and it is scarce to find farmers who are still young.

Experience in carrying out pineapple farming is one of the critical determining factors. The more experienced the farmer, the better he will be at carrying out farming activities related to resource management, anticipating pests and diseases, and various unexpected factors that cause crop failure. It is known that based on research that has been carried out, the average experience of farmers in pineapple farming in Pegasing District is more than 5 years. It can be concluded that the length of experience these farmers have greatly influences the pineapple farming business they undertake.

Table 2. Experience of Pineapple Farmers in Pegasing District

Farming Experience (Years)	Farmers number (Person)	Percentage (%)
0-5	0	0
> 5	62	100
Total	62	100

Source: Primary Data Processed, 2023

The number of farming family members is a key factor in determining the level of farmer needs. The more dependents a farmer has, the greater the living needs that must be met. This underscores the personal drive and commitment of farmers in pineapple farming, as they are motivated to meet their family's living needs.

Table 3. Amount of Farmer Family Members in Pegasing District

Scale Classification	Farmers number (Person)	Percentage (%)
2–4	40	65
> 4	22	35
Total	62	100

Source: Primary Data Processed, 2023

Based on the table above, the number of dependents who fall between classifications 2–4 is 40, with a percentage of 65% of the total respondents. Comparatively, 22 farmers, accounting for 35% of the total respondents, have more than 5 dependents. The number of dependents shows the level of needs the respondent farmer must meet.

Determinant Factors of the Production of Pineapple Farming

The most straightforward frontier production function uses an output-orientated perspective to describe the maximum production conditions. Technically, farming activities are more efficient than those of other farmers if the production process of inputs used has the same type or amount of input but the output produced is higher. To obtain technical efficiency values directly, the data can be analyzed using the stochastic frontier production function. One of the advantages of this stochastic frontier is that we can directly determine the technical efficiency value by looking at the t-ratio value and analyzing the maximum feasibility estimation method. Table 4. presents fronter production function of pineapple farming in Pegasing District.

Table 4. Estimated Frontier Production Function of Pineapple Farming

Parameter	Variable	Coefficient	t-Ratio
β0	Intercept	6.9355	6.9355***
β1	Land area	0.0312	3.2539***
β2	Seedlings	1.0152	6.7955***
β3	Labor	0.0408	0.0359ns
β4	Fertilizer	0.1198	0.1198 ns
β5	Pesticide	5.6239	16.7515***
Sigma-squared(σ2)		0.9126	9.1262***
Gamma (γ)		0.6600	6.6000***
Log Likelihood Function			4.3348***
Likelihood Ratio (LR)			23.9796***

Source: Primary Data, 2023
Information: ***significant at α = 1% (2.39357), **significant at α = 5% (1, 67203), * significant at α = 10% (1.29658), ns = not significant.

Table 4. indicates that the sigma-squared (σ2) value of 0.9126 and gamma (γ) of 0.6600 obtained from the MLE method estimation results are significant at the 1% error level. The value of $σ_2$ greater than zero explains the influence of production in the frontier model and indicates that the error term (μi) is normally distributed. The gamma value (γ) of 0.6600 indicates that the pineapple production is more influenced by various management factors of pineapple farmers in running their farming business. This indicates that the frontier production function model is appropriate to apply in explaining factors that cause the variation in the frontier production model. Table 4. above describes that the generalised-likelihood ratio (LWR) value is 23.9796, which indicates that the value is greater than the value in the code and palm table, which is 23.551. This result confirmed that the frontier production function is suitable for the production structure of pineapple farming in Pegasing District. As a basis for analysis, the stochastic frontier production function, a powerful tool, is used to obtain a frontier cost function or isocost frontier to obtain a price or allocative efficiency value and an economic efficiency value, the interpretation of each input variable in the stochastic frontier function model can be explained.

1) Land Area

The land area variable shows a significant influence. It is positively related to pineapple production at a = 1% with a variable coefficient value of 0.0312, which explains that if the land area variable is increased by 1%, pineapple crop production will increase by 0.0312%, assuming that other variables remain constant, *ceteris paribus*. The land used at the research location is classified as fertile land, which, of course, contains many nutrients that plants need. The results of this study are by research (Lubis et al., 2016), which states that land area has a significant and positive effect on pineapple farming with a coefficient value of 0.14. With the increase in farmers' land area, of course, it will also increase the amount of production, so of course, it will also have an impact on increasing farmers' income. Although the addition of land area will undoubtedly be challenging to do, it is necessary to increase income in other ways, for example, by economic efficiency on farming.

Based on the research results, the total land area of all pineapple farmers is 10.5 Ha, and the average area of pineapple land is 0.17 Ha/farmer, with a minimum land area of 0.06 Ha and a maximum area of pineapple land of 0.63 Ha. In general, the land that pineapple farmers work on is their land, and some of it is land that the village government has given them to manage, but there is no rental fee. The goal is only so that the land is not neglected. Four farmers were given arable land with an area of 0.25 hectares each, and the remaining 58 had their own land. As research (Adegbite, 2015) shows, land has a significant effect on 1% and (Yulida, 2012), explained that the size of the land influences pineapple production produced by pineapple farmers. However, other factors influence pineapple production, namely maintenance activities on pineapple plants and the administration of stimulant drugs (ethrel).

2) Seedlings

Seedlings have a significant effect and are positively related to pineapple plant production. The coefficient value of the seed variable, namely 1.0152, means that if farmers add 1% more seeds, pineapple production will also increase by as much as 1.0152% if other variables are considered constant, *ceteris paribus.* This is in line with research (Lubis et al., 2016), which states that seeds have a significant and positive effect on pineapple farming, with a coefficient of 0.11 and a confidence level of 5%. In line with research Adegbite (2015), the number of saplings or seeds significantly 5% affects pineapple production. Pineapple farmers in Pegasing District use local seeds that have been used for generations, which are classified as good and have resistance in the research area, in contrast to seeds imported from other areas, which, when cultivated, are not resistant to the climate in the research area. The seeds used were obtained from pineapple parents and traders selling local pineapples around the Takengon-Isaq causeway. The production pineapple farmers is influenced by the sea level of the land used in farming (Rahim, 2019).

3) *Labor*

The labor production factor was found to have an insignificant effect and had a positive relationship with pineapple farming. The labor input coefficient value is equal to 0.0408. This explains that if labor input (HOK) is increased by 1%, pineapple production will increase by 0.0408% if other variables are considered constant, *ceteris paribus*. This is because pineapple cultivation requires a small amount of labour, and the majority of farmers only use family labour and even only carry out pineapple farming alone because it is easy to care for. The average number of workers used in pineapple farming activities in Pegasing District is 44 HOK/Ha/production. This is in line with the study Andaregie et al., (2020), which found that labour affects charcoal production.

4) *Fertilizer*

Fertilizer inputs positively and insignificantly affected pineapple production, with a coefficient of 0.1198. This means that if farmers add 1% fertilizer, the amount of output will increase by 0.1198% if other variables are considered constant, *ceteris paribus*. In line with research (Adegbite, 2015; Yekti et al., 2017; Pawitri et al., 2021). Multiple linear regression and getting fertilizer did not significantly affect melon and rice production. However, it is different from Kewu et al., 2020; Adegbite, 2015 that fertilizer significantly influences the production of pineapple, rice and soybeans. Most farmers in Pegasing District use large quantities of organic fertilizer and only use chemical fertilizer during the initial planting period. The organic fertilizer that many farmers use is ground coffee pulp, which is usually obtained from coffee mills. The average use of organic fertilizer reaches 5.4 tonnes/ha/production. Apart from that, farmers only add chemical fertilizer for tillage and initial planting fertilizer at an average of 50 kg/ha/production. According to the Ministry of Agriculture's 2008 pineapple crop guidebook, farmers need to add chemical fertilizer during the planting period or supplementary fertilizer.

5) *Pesticide*

The pesticide production factor significantly and positively influences the quantity of pineapple crop production with a coefficient value of 5.6239. This means that if farmers add pesticides by 1%, the amount of production will increase by 5.6239% if other variables are held constant. This is in line with research (Yekti et al., 2017; Lubis et al., 2016). The pesticides used by farmers are to eradicate the growth of weeds pests and, diseases that disturb pineapple plants. The average use of pesticides in Pegasing District is 6.2 liters/ha. The use of pesticides in the field is relatively small. Farmers assume that the nature of the pineapple plant, which develops by sprouting, means that the pineapple leaves cover the land so that the weeds are not too dense, so there is no need to spray pesticides. In this case, farmers need to maximize the use of pesticides to eradicate weeds and plant pests in the aisles of the beds and between pineapple leaves.

Technical Efficiency Index Value

The technical efficiency index value of nasas farming in Pegasaing District, Central Aceh Regency, is categorized as ≤ 0.7 which is said to have not reached efficient, and if the index value is > 0.7, it is said to be efficient (Adhiana & Riani, 2019). Results of analysis of technical efficiency index values pineapple farming business shows that farmers in Pegasing District are as efficient as 85.48% of the total farmer respondents. As much as 14.5% is categorized as still inefficient. Farmers who have not yet achieved technical efficiency in pineapple farming still have to pay attention to the use of production factors so that their farming becomes more efficient. The lowest efficiency was achieved at a value of 0.54, and the highest was achieved at a value of 0.94, which shows that some farmers have achieved technical efficiency in carrying out pineapple farming in Pegasing District, the same as the research results (Adhiana & Riani, 2019). The use of fertilizer and labor is not technically efficient, the same as research (Pawitri et al., 2021), who used the multiple linear methods stated that fertilizer was not technically efficient in rice farming. Different from research (Keraru et al., 2023), who also used the Stochastic Frontier method, stated that the technical efficiency index value of pig farming was still relatively low. Whereas (Azzahra et al., 2022) found that the average productivity of the CPO industry decreases every year and shows low technical efficiency.

The average value of technical efficiency in pineapple farming activities was obtained at 80%, which illustrates that pineapple farmers, on average, have the opportunity to obtain more technically efficient results. This is in line with research of Moïse (2022) and Adegbite (2015), which showed that pineapple farmers have achieved technical efficiency with a value of 96% in Benin and 93% in Nigeria. In contradict to research of Baloguna et al (2018), Rahim (2019) Muhamad et al., (2023) that the efficiency of pineapple farmers has not been achieved with an efficiency value of 0.5 in Johor, 0.682 in Malaysia, and 0.603 in Nigeria. Farmers can improve technical efficiency in pineapple crops by allocating various production factors according to their needs, using inputs optimally, and implementing better management.

Allocative Efficiency and Economic Efficiency of Pineapple Farming

To obtain the level of rationality of farmers in conducting farming activities to obtain profits, it is usually analyzed using price efficiency or allocative analysis. The highest profit will be obtained if various factors of production are combined to achieve a high level of economic efficiency. The value of price or allocative efficiency and economic efficiency can be obtained by analyzing various production inputs. Analysis from the production input side using various input prices prevailing at the farm level can obtain the value of allocative and economic efficiency. As the basis of the analysis, a doubled stochastic frontier production function is used to obtain the cost frontier function or isocost frontier as follows:

$$\ln C = 0.0626 + 0.0038\ln P_1 + 0.0390\ln P_2 + 0.0016\ln P_3 + 0.0002\ln P_4 \\ + 0.001\ln P_5 + 6.8271Y$$

Related to deriving the dual cost function from the equation above, price or allocative efficiency values and economic efficiency values can be obtained. Then, the value of the distribution of price or allocative and economic efficiency of pineapple farmers can be seen in Table 2. It was found on average that at the prevailing price level, pineapple farmers in the research location had not achieved price or allocative efficiency, namely 0.427, similar to research by; Nurul et al., 2018; Adhiana, 2020; Jaya, 2021 that it is not yet allocative efficient for oil palm farming in Kawaringin, rice farming in Kbebasan and corn farming in Tanjung Morawa. Idrus & Suyatno (2021) found that the price efficiency value of pineapple farming activities was not efficient in the variables of land area, UREA, TSP, Phonska, and labor in Rasau Jaya District. Different from (Irsyadul et al., 2022) using the Cob Douglas analysis method, allocatively or price-wise, white mustard farming has reached an efficient value because the NPMx/Px value equal to one.

Table 5. Allocative And Economic Value Of Pineapple Farming

Efficiency Level	Price efficiency		Economic efficiency	
	Amount	Percentage	Amount	Percentage
0≤ 0.3	8	12.90	7	11.29
>0.3≤ 0.5	51	82.26	53	85.48
>0.5≤ 0.7	3	4.84	2	3.23
>0.7≤ 0.9	0	0.00	1	0.00
>0.9≤ 1.0	0	0.00	0	0.00
Total	62	100.00	62	100.00
Average	0.427		0.351	
Minimum Value	0.313		0.294	
Maximum Value	0.657		0.472	

Source: Primary Data, 2023

Combine the values of technical efficiency and price or allocative efficiency. You will get a value that is less economically efficient for farmers in the research area, namely (0.3231) and different from the research (Machmuddin et al., 2017) which obtained a relatively high economic efficiency value for organic rice, namely for the variables of land area, plant seeds, and labor. Whereas (Andaregie et al., 2020) found that the variables that influencing charcoal productivity are land area, seeds, and labor. The estimated economic efficiency value score is 85%. Below, you can see the price or allocative and economic efficiency values of pineapple farming.

Table 5. above explains that the average price or allocative efficiency value only reached 31.1% and the average economic efficiency value was 35.1%, which shows that price or allocative efficiency and economic efficiency still need to be achieved. This situation shows that pineapple farmers must optimize the use of production inputs and reduce production input costs to maximize pineapple production output. The results of this study align with (Agustina et al., 2022), who used the multiple linear regression method and found that the results of the economic efficiency analysis showed that the use of soybeans had not achieved economic efficiency. Different from studies (Akhilomen et al., 2015), the average technical, allocative, and economic efficiency of farmers is 0.70, 0.68, and 0.64, respectively, which indicates that there are broad opportunities for farmers to increase their productivity. The Cobb-Douglas production function approach and found that pineapple farmers in Sumatra did not use inputs optimally.

Economic Efficiency

Economic efficiency consists of technical and allocative efficiency. The economic efficiency of pineapple farming can be seen from the technical and allocative efficiency level. The mathematical value of economic efficiency is expressed as follows.

Economic Efficiency (EE) = Technical Efficiency x Price efficiency

EE = 0.80 x 0.427

EE = 0.351

The average value of technical efficiency for pineapple farmers is 0.80, meaning that the average production of pineapple farming operated by pineapple farmers in Pegasing District, Central Aceh Regency, has reached technical efficiency. The distribution of allocative efficiency values for pineapple farmers is at a minimum of 0.313 and a maximum of 0.657, with an average value of 0.427. The average value of allocative efficiency reached 0.427, which shows that most pineapple farmers have not achieved the expected allocative efficiency, which is equal to 1.

Pineapple farmers in Central Aceh Regency have an average economic efficiency value of 0.351 with a minimum value of 0.294 and a maximum value of 0.472. This value indicates that the average pineapple farmer is inefficient because the economic efficiency value is not equal to 1. In line with research Adhiana et al., (2021), who used the Stochastic frontier method, they also found that the economic efficiency value of red chili farming in North Aceh had not been achieved. This is different from studies Lanamana (2020) that found that the average level of economic efficiency of Nggela corn farming was 87%. Meanwhile Akhilomen et al., (2015) also used a stochastic frontier and obtained an average economic efficiency of pineapple farmers in Edo, Nigeria of 0.64, which shows that there are broad opportunities for farmers to increase their productivity. Nursalam et al., (2021) also using the stochastic frontier method, it was found that the cocoa+coconut+patchouli intercropping farming system had better technical, allocative, and economic efficiency index values and was more feasible to cultivate compared to other patterns. Merliana et al., (2020) found that Mina Padi farming did not achieve economic efficiency in using various production factors in Mina Padi. The the Cobb Douglas production function approach result show that the input has not been used optimally.

CONCLUSION AND SUGGESTION

Conclusion

Factors that influence the technical efficiency of pineapple farming are land area, number of seeds, and pesticides, and have a significant effect on pineapple production. Meanwhile, the labor and fertilizer input variables do not significantly affect the amount of pineapple farming production. This pineapple farming business has also achieved technical efficiency and shows that pineapple farmers have used an optimal combination of inputs. However, allocatively and economically, pineapple farming has not yet reached efficiency, so efforts need to be made to reduce input costs. Using the right combination of inputs, economic efficiency will be obtained from the use of production factors so that pineapple farmers' income will increase, as well as improving cultivation practices and resource management at the farmer level, which is more technically and price efficient.

Suggestion

Using a stochastic frontier approach, this research only analyzes efficiency from a technical, allocative and economic perspective using a stochastic frontier approach. Future researchers should use other analysis methods such as DEA (Data Development Analysis) or others. Pineapple farming is a very promising type of fruit production activity. The research is expected to provide information as a form of advice for farmers as farming actors in carrying out cultivation to apply the right combination of inputs; economic efficiency will be obtained from the use of production factors so that pineapple farmers' income will increase.

ACKNOWLEDGMENT

We would like to thank the Head of the Central Aceh BPS office, and the respondents who have helped complete this article.

REFERENCES

Adegbite, O. I. (2015). Technical Efficiency Of Pineapple Production In Osun State, Nigeria. *AgEcon Search (Agricultural & Applied Economics),* 07(1), 3-12. doi: 10.22004/ag.econ.207051

Adhiana, & Riani. (2019). *Analysis Of Economic Efficiency Of Farming: Stochastic Production Frontier Approach.* Aceh: Sefa Bumi Persada

Adhiana, A., Martina, R., & Suryadi. (2021). The Analysis Of Economic Efficiency Of Red Chilli Business In Sawang Subdistrict, North Aceh. *International Journal Of Economic, Business, Accounting, Agriculture Management And Sharia Administration (IJEBAS),* 1(2), 112–122. doi: 10.54443/ijebas.v1i2.21

Adhiana. (2020). Analysis Of The Allocative Efficiency Of Cassava Farming In Tanjung Morawa District, Deli Serdang Regency, North Sumatera Province. *Agrifo Journal,* 5(2), 151–158. doi: 10.29103/ag.v5i2.3891

Agustina, R. N., Rahayu, W., & Barokah, U. (2022). Economic Efficiency Of The Use Of Production Factors. *Agrisocionomics: Journal Of Social Economics And Agricultural Policy,* 6(1), 50-57. Retrieved from http://ejournal2.undip.ac.id/index.php/agrisocionomics

Aigner, D., Lovel, C. A. K., & Schmidt, P. (1977). Formulation And Estimation Of Stochastic Frontier Production Function Models. *Journal Of Econometrics*, 6(1), 21-37. doi: /10.1016/0304-4076(77)90052-5

Akhilomen, L. O. G. M. (2015). Economic Efficiency Analysis Of Pineapple Production In Edo State, Nigeria: A Stochastic Frontier Production Approach. *American Journal Of Experimental Agriculture*, 5(3), 267-280. doi: 10.9734/AJEA/2015/13488

Andaregie, A., Worku, A., & Astatkie, T. (2020). Analysis Of Economic Efficiency In Charcoal Production In Northwest Ethiopia: A Cobb-Douglas Production Frontier Approach. *Trees, Forests And People*, 2, 1-7. doi: 10.1016/j.tfp.2020.100020

Azzahra, W. S. D., et al. (2022). Technical Efficiency AND Productivity Growth OF Crude Palm Oil: Variation ACROSS Years, Locations, AndFirm Sizes In Indonesia. *Economies,* 10(12), 1-24. doi: 10.3390/economies10120303

Badan Pusat Statistik. (2022). *Central Aceh In Figures 2022 (1st ed.).* Central Aceh Regency BPS. Retrieved from https://aceh.bps.go.id/publication/2022/02/25/da6a9c25fb21c5c215819e68/provinsi-aceh-dalam-angka-2022.html

Baloguna, OL, SA-B. (2016). Profitability And Technical Efficiency Of Pineapple Production In Ogun State, Nigeria. *International Journal Of Fruit Science,* 18(4), 436–444. doi: 10.1080/15538362.2018.1470594

Coelli, T. D. S. P., & Rao, B. G. (1998). *An Introduction To Efficiency And Productivity Analysis.* Boston (US): Kluwer Academic Publishers

Debertin, D. L. (1986). *Agricultural Production Economics (Second Edition).* New York: Macmillan Publishing Company

Idrus, Y. E., & Suyatno, A. (2021). Efficiency Of Allocative Pineapple Farming In Rasau Jaya Kubu Raya District. *Journal Of Agricultural Economics And Agribusiness (JEPA*), 5(3), 853–861. doi: 0.21776/ub.jepa.2021.005.03.22

Irsyadul, M. M., Syafrial., & Widyawati, W. (2022). Analysis Of Allocative Efficiency On The Use Of Production Factors And Farming Business Income Of Chinese Cabbage *(Brassica pekinensis L.). Journal Of Agriculture Economic And Agribusiness,* 6(4), 1389–1404. doi: 10.21776/ub.jepa.2022.006.04.16

Jaya, A. P. (2021). Allocative Efficiency Of The Use Production Factors: Empirical Study On Red Chili Farming In Pakem Subdistrict. *Agrisocionomics: Journal Of Agricultural Socioeconomics And Policy,* 5(2), 64–74. doi: 10.14710/agrisocionomics.v5i2.8871

Keraru, E. N., Harianto, H., & Yusalina, Y. (2023). Technical Efficiency Of Small-Scale Pig Farming In Indonesia. *SOCA: Journal Of Social, Agricultural Economics,* 17(1), 27-38. doi: 10.24843/soca.2023.v17.i01.p03

Kewu, F., Kardi, C., & Sukanteri, N.P. (2020). Efficiency Of Using Production Factors In Large Chili Farming In Titigalar Village. *AGRIMETA: Agricultural Journal,* 10(20), 7–12. Retreived from http://ejournal.unmas.ac.id/index.php/agrimeta/article/view/1781%0Ahttp://ejournal.unmas.ac.id/index.php/agrimeta/article/download/1781/1418

Kopp, R. J., & Diewert, W. E. (1982). The Decomposition Of Frontier Cost Function Deviations Into Measures Of Technical And Allocative Efficiency. *Journal Of Econometrics,* 19(2), 319–331. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/0304407682900082

Kumbhakar, C. L. (2003). *Stochastic Frontier Analysis (2003rd Ed.).* Cambridge: The University The Cambridge

Lanamana, W. (2020). Measuring The Economic Efficiency Of Nggela Corn Farming (Jawa Nggela) In Ende Regency. *Agrica,* 10(2), 43–51. doi: 10.37478/agr.v10i2.196

Lubis, R. R. B., et al. (2016). Analysis Of Technical Efficiency Of Pineapple Production: Case Study In Subang Regency, West Java. *Journal Of Agro Economics,* 32(2), 91-106. doi: 10.21082/jae.v32n2.2014.91-106

Machmuddin, N., Kusnadi, N., & Syaukat, Y. (2017). Analysis Of The Economic Efficiency Of Organic And Conventional Rice Farming In Tasikmalaya Regency. *Agribusiness Forum*, 6(2), 145–160. doi: 10.29244/fagb.6.2.145-160

Merliana, A., Setiawan, B. M., & Budiraharjo, K. (2020). Economic Efficiency Of Regular Rice Farming And Mina Padi Production Factors. *SOCA: Journal Of Agricultural Socioeconomics,* 15(3), 531-538. doi: 10.24843/SOCA.2021.v15.i03.p10

Moïse, K. B S., & A. A-I. (2022). Technical Efficiency Of Pineapple Production And. *African Journal Of Agriculture,* 18(7), 522-534. doi: 10.5897/AJAR2021.15677

Muhamad, Z. M., Syamsudin, M., & Kamaluzaman, N. W. (2023). Assessing Technical Efficiency In Malaysian Pineapple Farms: A Stochastic Frontier Analysis Approach. *Emirates Journal Of Food And Agriculture,* 35(12), 1-9. doi: 10.9755/ejfa.2023.3201

Nursalam, N., et al. (2021). Efficiency Comparison Of The Cacao Intercropping Farming In Kolaka Regency. *Agrieconomics,* 10(2), 183–193. doi: 10.21107/agrieconomica.v10i2.11090

Nurul, R., et al. (2018). Allocative Efficiency Analysis Of Production Factors Usage On. *Journal Of Agricultural Economics And Agribusiness (JEPA),* 2(1), 10–18. doi: 10.14710/agrisocionomics.v5i2.8871

Pawitri, G., Budiraharjo, K., & Mulyatno Setiawan, B. (2021). The Production Efficiency In Organic Rice Farming. *SOCA: Journal Of Social, Agricultural Economics,* 15(3), 450-457. doi: 10.24843/soca.2021.v15.i03.p03

Rahim, S. N. (2019). Technical Efficiency Of The Pineapple Smallholders At Johor: Data Envelopment Analysis. *International Journal Of Academic Research In Business And Social,* 9(3), 746–755. doi: 10.6007/IJARBSS/v9-i3/5740

Witharana, D., Amarasuriya, H., & Uvais, H. (2007). Rethinking The Link Between Trade And Development A Discussion Based On The Framework Of The Proposed India Sri Lanka. *Comprehensive Economic Partnership Agreement (CEPA),* 1-34. Retrieved from https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=b65dcdd6fe6e43ef25df16a7fd84b531bd2284dc

Yekti, A., et al. (2017). Technical Efficiency Of Wet Season Melon Farming. *Traces,* 10(1), 12–29. doi: 10.15294/jejak.v10i1.9124

Yotopoulos, P. A., & Lau, L. J. (1973) Test For Relative Economic Efficiency: Some Further Results. *The American Economic Review,* 63(1), 214–223. doi: 1803137.jstor.org/stable/1803137