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Measuring Economical Efficiency in Raising Pigs: Evidence from Indigenous Papuan Farmers, West Papua.

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Abstract | This study aims to analyze the factors that affect the production and technical, allocative, and economic efficiency of Indigenous Papuan pig farmers in Manokwari Regency. The method used is the Ordinary Least Square (OLS) and Maximum Likelihood Estimation (MLE) methods on the Cobb-Douglas production function model and the Technical Efficiency Effect Model option. The results showed that piglets, feed, and firewood had an effect on pig production. Pig farmers in Manokwari Regency have been allocatively efficient, but technically and economically inefficient.

Keywords | Pigs, Efficiency, Production function, Indigenous, Farmers

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INTRODUCTION

The development of the livestock sub-sector is an integral part of agricultural development in particular and national development in general. The development of the livestock sub-sector has several objectives, including meeting the community's need for animal protein, expanding job opportunities, and increasing the income of farmers, which in turn is expected to improve the standard of living of farmers. To meet the community's need for animal protein, pigs are one of the most potential meat-producing livestock to be developed. This livestock has advantages compared to other types of livestock because it has high economic characteristics, namely high body weight gain, reaching (0.5-0.7 kg/day), and is capable of giving birth five times in two years with an average number of children. Averaging 6-12 birds per birth, it has a high ration conversion (2.4-3.4 kg of feed) and a carcass percentage of 70-80% (Aritonang, 1993). West Papua Province and Manokwari Regency in particular are considered to have the potential for smallholder pig farming. This is supported by the Development of Strategic Areas for Leading Livestock because Manokwari Regency is designated as a Strategic Area for Leading Pig Livestock Development according to KEPMENTAN No.43/KPTS/PD.010/I/2015. Pigs are raised by the community in almost all areas of West Papua Province, by those who live on the coast, inland, or around the city. This is done because, apart from being a source of meat for the family, pigs also have economic value that can contribute to increasing income, as well as having strong social and cultural values (Gregory & Grandin, 2007). This advantage indicates that this business has economic value and can provide considerable profits and can be used as family savings, which can be sold at any time to get cash for the necessities of life for family members (Pattiselanno & Iyai, 2005). According to (Randa, 1994), the indigenous people of Irian Jaya (now Papua) still raise pigs traditionally. Pigs are allowed to roam freely looking for food. Only a very limited number of residents provide cages that meet the requirements. Furthermore, the largest proportion of

the population raises pigs not for commercial purposes (a source of income), but for social purposes, following prevailing customs. The pig rearing system run by the community in Manokwari Regency is divided into two, namely the intensive rearing system (cage) and the semi-intensive rearing system (released to look for food and then returned to the pen again) or sometimes released freely without providing permanent housing. This rearing system can be improved if the maintenance pattern becomes intensive to increase the income of pig farmers if managed properly (Randa, 1994). If the number of products produced by the unit of production elements used is large, it is said to be good (efficient).

Manokwari Regency is one of the areas with great potential for the development of pig farming because in this area the pig population is quite high. The latest data from the Department of Agriculture, Livestock and Plantation of Manokwari Regency shows that the population of pigs experienced a very small decline of only 1% from 2013 to 2016, from 46,141 to 37,078 heads due to high slaughtering or shipping out of Manokwari. Meanwhile, meat production went from 76,934 kg in 2013 to 383,020 kg in 2016 (Pattiwaellapia, 2023). This is due to the high rate of slaughter of pigs for consumption and the implementation of traditional ceremonies. Based on the data above, both from the technical, economic, and regional conditions, this area has a lot of potential for the development of the pig farming business. However, this potential has not been utilized optimally because most of the existing pig farming businesses are still limited to running as a side business. This means that the business being run is not oriented to the right market and it is only sold from time to time to meet family needs and events. such as on religious holidays and traditional parties. Economically, side businesses often do not provide maximum benefits to farmers due to inefficient use of production factors. This condition has been going on for years, which has resulted in low incomes for livestock farmers and pig farmers. By looking at the impacts and developments in various sectors recently, the business of pig farmers in Manokwari Regency needs to be developed in terms of the existing potential. This business will provide benefits for farmers if it can be managed using appropriate economic principles. Utilization of production factors efficiently and the right demand will provide maximum benefits to farmers. Thus, information is needed on whether the farmers have developed their production activities efficiently and what factors affect business efficiency and what factors most influence the efficiency of pig farming.

The objectives of the study

Analyzing the technical, allocative, and economic efficiency of indigenous papuan pig farmers in Manokwari Regency.

Analyzing the production factors that affect the efficiency of indigenous papuan pig farmers

Determine the efforts of indigenous Papuan pig farmers in Manokwari, West Papua, to achieve economic efficiency

RESEARCH METHODS

Date and time: This research was conducted in Manokwari Regency. This research lasted for 1 month, starting from March 2018 to April 2018. The subjects in this study were pig farmers in Manokwari Regency. The pig breeders used as samples were 68 breeders spread across Prafi District, South Manokwari, West Manokwari, and East Manokwari District. The method used in this research is a survey using a questionnaire.

Research variable: The output value is the value obtained from the production of pigs (seed sales and meat sales). The input variables consist of eight, namely: pig breeds, feed, vaccines, medicines, and vitamins; labor; electricity and fuel; and the size of the cage. These variables include the age of the breeder, the experience of the farmer, the level of education, and the gender of the breeder.

Data analysis

The data obtained was carried out by the Classical Assumption Test to find out whether the data used was the Best Linear Unbiased Estimator (BLUE),

To find out the factors that affect the production function of the pig farming business, tests were carried out using the Ordinary Least Square (OLS) and Maximum Likelihood Estimation (MLE) methods on the Cobb-Douglas production function model. To analyze the level of technical efficiency, efficiency analysis is carried out with the option of the Technical Efficiency Effect Model. For the analysis of the Return to Scale (RTS) in this study, it was done by adding up the coefficients of determination of the factors of production based on the results of the Maximum Likelihood Estimation (MLE);

This study's data was analyzed using Microsoft Excel 2010, Minitab 18, and Frontier version 4.1c.

RESULTS AND DISCUSSION

Analysis of Production Functions

The results of the study indicate that the input factors together affect production. This is evidenced by the coefficient of determination of 0.962. This value means that the independent variables together can explain 96.20% of the variation in pig livestock production. Then, based on the calculated F value, which is 184.54, and this value is greater than the F-table at = 0.05db1=68, db2=59, namely, 1.523.

Table 1: Results of Analysis with Ordinary Least Squares (OLS)

Variables	Koefisien	Std-Error	T-Ratio
Constant	0.43043	0.93293	0.46138
Piglet(X1)	0.97972	0.10148	0.96536
Feed (X2))	0.48991	0.85812	0.57091
Medicines, vitamins, and vaccines (X3)	-0.12588	0.22358	-0.56303
Labor (X4)	-0.91123	0.65253	-0.13964
Electric (X5)	-0.33778	0.12038	-0.28058
Wood Fuel (X6)	0.34278	0.13911	0.24640
Fuel Oil (X7)	0.27516	0.30058	0.91543
Cage area (X8)	0.64461	0.66065	0.97571
R-Sq (adj)			0,962
F-Value			184,54

Source: primary data 2021

Table 2: Analysis Results with Maximum Likelihood Estimation (MLE)

Variables	MLE		
	Koefisien	Std-Error	T-Ratio
Constant	3,88741	0,43347	8,96807
Piglet(X1)	0,78108	0,09197	8,49235**
Feed (X2))	0,12739	0,02576	4,94377**
Medicines, vitamins, and vaccines (X3)	-0,34261	0,20285	-1,68890
Labor (X4)	-0,09182	0,04967	-1,84866
Electric (X5)	-0,06195	0,09483	-0,65327
Wood Fuel (X6)	0,35745	0,12479	2,86422*
Fuel Oil (X7)	0,14232	0,16724	0,85098
Cage area (X8)	-0,01965	0,04981	-0,39463

Source: primary data 2021

MLE METHOD FOR ANALYZING PRODUCTION FUNCTIONS

The results of the analysis of the stochastic frontier production function in pig farming using the Maximum Likelihood Estimation (MLE) method are shown in Table 2.

Piglet: The regression coefficient of the piglet variable is 0.78108, meaning that for every 1% increase in piglets, the production of pigs will increase by 0.78108%. Variable piglets influence the amount of production of the pig livestock business. This is presumably because piglets are the main raw material in the production of pig farming, without piglets this business would not be possible. Piglets with good quality will be very supportive and give good results. According to (Murwanto, 2008), high-quality of piglet can guarantee a pig farming business to get a decent profit. Provision of rations and good management does not guarantee good growth and efficient use of feed if the piglets used do not have good traits or genetics to achieve the goal. This is following the opinion of (Umeh et al., 2015), namely piglets are a more important factor among other factors, and superior piglets resulting from crossbreeding have larger bodies and grow faster than local pigs. Therefore, the use of quality piglets is a start and has a better chance of increasing the production of pigs.

Feed: The results of statistical tests that feed variables influence pig production. This is evidenced by the value of the T-Ratio greater than the T-table (4,94377 > 2,00099). The regression coefficient of the feed variable is 0.12739, which means that every 1% increase in the feed will increase the production of pigs by 0.12739. The reason is suspected because feed is a source of energy that is needed for the body of livestock. If the quality and quantity of feed are reduced from what is needed by the animal's body, the production will decrease. (Djawa, 2022) states that pigs need feed with balanced and perfect nutrition, to obtain optimal reproduction and meat production. The results of this study are following the results of research conducted by (Widayati et al., 2018) that feed has a positive effect on pig production in Doreri Bay, Manokwari Regency and most of the feed used by farmers comes from garden products (yams) and household waste, and tofu dregs. According to (Pattiselanno et al., 2011) pig farmers in the area around the Ma-

nokwari coast generally provide a mixed feed from garden produce, food stall waste, market waste, kitchen waste and tofu paste to pigs, because it is cheaper and easier to obtain than using the commercial feed.

Medicines, vitamins, and vaccines: Drugs, vitamins, and vaccines (DVV) variables have a negative regression coefficient of -0.34261, which means that every 1% addition of DVV will reduce pig production by 0.34261%. Meanwhile, the resulting T-count is still lower than the T-table or -0.16889 < 2.00099. This shows that statistically, the use of DVV does not affect the production of pigs. This is presumably because the pig farming system is generally still traditional, where the use of drugs, vitamins and vaccines is very rarely done due to limited costs, knowledge, and availability. Sources of various feed ingredients from garden products, agricultural waste, and kitchen waste are also thought to contain vitamins needed by pigs, so vitamin intake is only obtained from the feed ingredients provided. Different from the results found by Umeh et al. (2015); Aminu & Akhigbe-Ahonkhai, (2017) that the variables of drugs, vitamins and vaccines have positive coefficients, although they have no significant effect at the 10% level on pig farming in Nigeria. It is suspected that the maintenance system, breeder characteristics and maintenance management applied in the country are much better.

Labor: Labor has no influence on the production of pigs. It is suspected that the amount of labor used has exceeded the normal limit for the use of labor in a pig farming business, while the amount of time given is low. Workers in the traditional pig rearing system generally use several family members who take turns to help run the business, while the amount of time given is not proportional to the number of workers. If the number of hours worked as a benchmark may be different, such as the results of research obtained by (Widayati et al., 2018), the outpouring of working hours of farmers has a positive effect on the productivity of pig farming in Doreri Bay. Umeh et al. (2015) and Zhang et al. (2019) also obtained the same result, namely the outpouring of working hours for pig farmers in Nigeria has a positive effect on production and business income. This is because farmers give more time to take care of pigs so that pigs are better cared for and their production can increase.

Electric: The use of electricity does not affect pig livestock production. These results are thought to be due to the small amount of electrical energy used and only for lighting if there is an activity in the pen at night, and this is rarely found in pig farms in general, because the activities of farmers in the pen are more often carried out during the day.

Wood Fuel: The wood fuel coefficient is 0.35745, which means that every 1% increase in the use of wood fuel will increase the production of pigs by 0.35745%. Wood fuel affects Pig livestock production. It is suspected that because of the traditional pig rearing system, the role of wood is very important as fuel for feed processing because wood fuel is cheaper and easier to obtain than having to use kerosene-fueled cooking utensils.

Fuel Oil: Based on statistical analysis that fuel oil affects Pig livestock production. This result is presumably because the use of fuel oil is quite high, especially as a substitute for fuel wood and transportation fuel oil which is used for various purposes related to pigs, such as finding and transporting feed, as well as transporting wood fuel.

Cage Area: The size of the cage does not affect the production of pigs. This is presumably because the environmental conditions of the cage and feeding are good enough so that the pigs do not experience stress. Van de Weerd & Ison, (2019) and Fletcher, (2015) states that if pigs are under stress due to unsuitable cage environmental conditions, it will affect the balance of hormones and enzymes which in turn will affect livestock metabolism, and affect production.

Technical Efficiency: The results showed that the average level of technical efficiency achieved was 0.63. This indicates that the overall average productivity of Pig livestock business in Manokwari Regency is 63.00% of the frontier. These results indicate that pig farmers in Manokwari Regency are not yet technically efficient. Different from the results found by Pakage et al., (2014); Umeh et al. (2015); Djawa, (2022); Latruffe et al. (2013); Cabas Monje et al. (2023) in pig farming in Nigeria, the average efficiency is quite high, namely 0.97 or 97% of the frontier, almost close to the maximum efficiency. It is suspected that the maintenance system, characteristics, seeds, and management applied there are better than those in Manokwari Regency. Pig farmers in the research location are still able to add some input variables and reduce excessive use of inputs. The added input variables are 0.3700%. The input variables that can be further improved in efficiency are for example piglets, feed, wood fuel, and fuel oil which are proven to affect livestock production. If the technical efficiency of these factors is improved, the costs can be reduced so that the income received will be maximized. The profit of a pig farming business depends on the efficiency of how to produce pigs and the efficiency of marketing, the higher the efficiency value achieved by the farmer, the higher the profit obtained (Onyenweaku & Effiong, 2005; Labajova et al., 2016).

Table 3: Category of Technical Efficiency of pig farming in Manokwari Regency

Category TE	Farmers (person)	Farmers (%)
< 0,5	20	29,41
0,5 – 0,7999	26	38,24
0,8 – 0,9999	22	32,35
Total	28	100

source: primary data 2021

A total of 22 farmers are in the high category, and the rest are in the medium and low categories. This diversity is thought to be due to the method of using production factors, maintenance management, environmental conditions, culture, and other factors of different breeders. According to Pakage et al. (2015) and Lansink & Reinhard, (2004), the diversity of technical efficiency values is caused by differences in knowledge, mastery, and ability to make decisions in managing a livestock business. Sihombing, (2006) also states that differences in the character of the breeder in regulating, managing, and making decisions will affect the level of efficiency, production, and profits obtained by the pig breeder.

Allocative Efficiency

The production process of a product always uses several inputs in optimal quantities to obtain a maximum number of production results. The use of production factors will differ between business actors. The difference is thought to be caused by differences in the ability of farmers, both knowledge of livestock business and financial management capabilities. These differences result in differences in the proportion of use of factors of production and prices of factors of production. This will have an impact on the profits obtained by farmers. Therefore, with the different capabilities of farmers, it will also be different in maximizing profits. The efforts of pig farmers in maximizing profits can be seen from the achievement of allocative efficiency values. The distribution of allocative efficiency values achieved by pig farmers is presented in Figure 1.

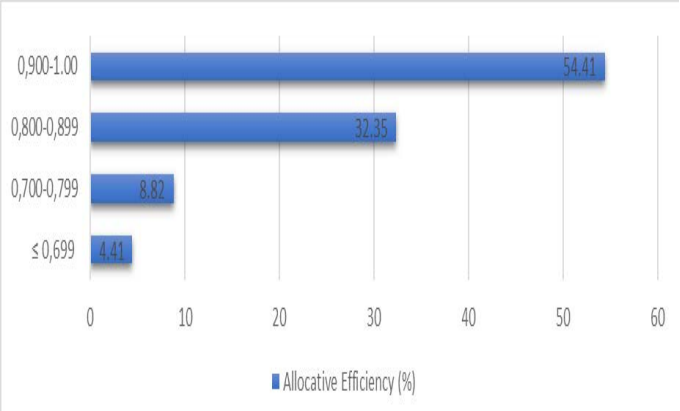

Figure 1: Distribution of allocative efficiency values among pig farmers in Manokwari Regency.

Figure 1 shows that the distribution of allocative efficiency values in pig farming is mostly in the range of values between 0.900 to 1.00 with the proportion of farmers as much as 54.41 percent. Based on the value of allocative efficiency achieved by pig farmers, there are differences in knowledgeability in using and financial ability to provide production factors between farmers. However, most pig farmers are allocatively efficient. This can be seen in as many as 86.76% of farmers who have an allocative efficiency value greater than or equal to 0.80. As many as 8.82% of pig farmers in Manokwari Regency The average allocative efficiency value of pig farming is 0.882. These results indicate that the average pig farmer has maximized the level of profit or the average pig farmer has used an optimal number of inputs to produce maximum production (Labajova et al., 2016; Gregory & Grandin, 2007).

Economic Efficiency Analysis

The level of success of the performance of pig farmers can be known through the use of several inputs to produce high production at the lowest possible cost. The success rate of pig farming business can be said to be economically efficient if the farmers are technically efficient in using the production factors by streamlining the prices of these production factors. The level of success achieved by breeders will differ from each other due to differences in the level of knowledge and ability of the pig farming business. The achievement of economic efficiency of pig farmers is shown in Figure 2.

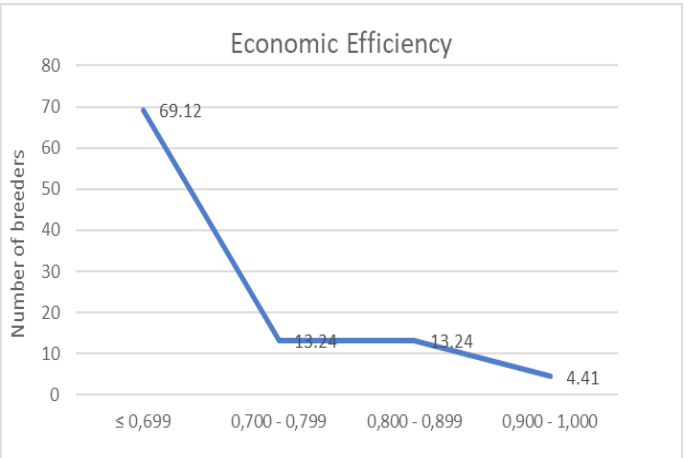

Figure 2: Distribution of Economic Efficiency in Pig Farming Business in Manokwari Regency

The economic efficiency value obtained by pig farmers varies from 0.145 to 0.914. Based on the distribution of the economic efficiency values achieved, there are differences in the use of production factors with minimum costs to produce maximum production. This shows that if the assessment is based on the achievement of the lowest efficiency value, the pig breeder is optimizing the use of production factors with the minimum possible cost. The distribution of the value of economic efficiency is a measure to determine the good and bad conditions of the pig farming business. The performance of a business sector in good condition will form a distribution pattern in the form of a half-normal curve. The business is in good condition if the highest distribution frequency is on the right side of the curve or Roca et al. (2016) that the distribution is in the range of 0.800 to 1.00. The findings in this study are inversely proportional to the above statement, but are the same as the findings Aminu & Akhigbe-Ahonkhai, (2017); Cabas Monje et al. (2023). This improving business condition is also indicated by the average achievement of the overall economic efficiency of pig farmers. This achievement shows that the overall average success rate for minimizing the costs of production factors used in pig farming is around 0.550 percent of the frontier. With the average value of economic efficiency, that achievement is not close to the minimum cost level that should be used by farmers by allocating their various resources. Thus the farmer has a 45 percent opportunity to minimize the cost of using the factors of production.

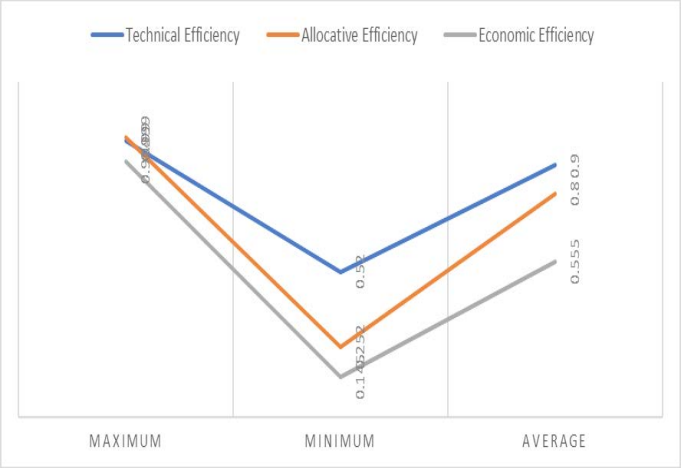

Figure 3: Average, Maximum, and Minimum Value of Technical, Allocative and Economic Efficiency Pig farming business in Manokwari Regency.

The average value of economic efficiency achieved by pig farming is 0.550. This shows that on average all pig breeders have different abilities in minimizing production costs by using some production factors. The difference in ability is thought to be since all the factors of production used come from different sources, which causes variations in the prices of the factors of production. This supports the statement of Yotopoulos & Nugent, (1976) and Adetunji, (2012) that in economic efficiency several similar businesses can be carried out in the same place, but will face different prices of production factors.

How to Achieve Economic Efficiency

The efforts of Papuan pig breeders to increase efficiency are
1. Increase the number of piglets by increasing the birth frequency of pigs.
2. Improve feed quality by adding commercial feed
3. Planting trees in the yard of the house to be used as firewood
4. Reducing the use of Medicines, vitamins, and vaccines; labor and electricity

CONCLUSION

The conclusions of this study are:
1. The factors that affect the production of pigs are piglets, feed, and fuel wood.
2. Pig farmers in Manokwari Regency are technically and allocatively efficient, but economically not efficient.
3. Increase the number of piglets, improve feed quality, planting trees as firewood and reducing the use of medicines, vitamins, and vaccines; labor and electricity

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

NOVELTY STATEMENT

The novelty of this research is efficiency in pig farming by Indigenous Papuan Farmers.

AUTHORS CONTRIBUTION

SP, DK, TWW writing concept.
SP, AGM, AB, DYS and DW Field data analysis and statistics.
SP, DK, TWW, DAI, AGM, AB, DYS and DW wrote the final manuscript.

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