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TECHNICAL EFFICIENCY OF HORTICULTURAL FARMING IN CIANJUR DISTRICT

Rohayati Suci Indrianingsih[1*], Eliana Wulandari[2], and Tuti Karyani[2]
[1]Agricultural Economics, Faculty of Agriculture, Universitas Padjadjaran, Bandung, West Java, Indonesia
[2]Agricultural Social-Economics, Faculty of Agriculture, Universitas Padjadjaran, Bandung, West Java, Indonesia

*Correspondence Email: rohayati21001@mail.unpad.ac.id

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ABSTRACT

Efficiency is important in horticultural farming, but farmers still do not understand how the concept is to achieve efficiency. This study aims to determine the factors of production that influence the production of horticulture in particular pakcoy and determine the efficiency level of pakcoy farming. The research design is quantitative with a survey method by distributing questionnaires. Questionnaires were distributed to 30 respondents who obtained by simple random sampling. The data were analyzed using multiple linear regression and stochastic frontier analysis. The research was conducted in Cipanas Sub-district, Cianjur District from August to November 2022. The results showed that the production factors related to the production of pakcoy were the use of ZA fertilizer and Score pesticide. ZA fertilizer and Score pesticide have a positive relationship with pakcoy production. Pakcoy farming in Cipanas Sub-district, Cianjur District can be identified as efficient. Efficiency in pakcoy cultivation in Cipanas District can still be improved to achieve maximum efficiency. Efficiency can be increased by adding the quantity of several production factors that are positively related to production, as well as reducing the use of production factors that have a negative relationship with production. Farmers can attend training on increasing technical efficiency so they can understand the concept of technical efficiency and apply it in their business.

Keywords: *horticulture, pakcoy, production function, stochastic frontier, technical efficiency*

BACKGROUND

In Indonesia, agriculture has several sub-sectors which include food crops, animal husbandry, plantations, forestry, fisheries, and horticulture sub-sectors. The horticulture sub-sector is one of the agricultural sub-sectors which has become a strategic commodity (Untari et al., 2022). The horticultural crops sub-sector has a contribution of 1.55% to the National Gross Domestic Product (GDP) in 2021 (BPS, 2021). The number of households working in the horticulture sub-sector is 10.60 million households (16.87%). Increasing production, increasing the value of export volumes, reducing imports, and increasing the welfare of farmers are the goals of horticultural development. Horticultural commodities, especially vegetables and fruits are commodities that have high commercial value (Putri et al., 2021).

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Horticultural commodities, especially vegetables, fruits and bio-pharmaceuticals are important commodities for the community. Apart from food, people usually cannot be separated from vegetables and fruit. Vegetables and fruit are commodities that people need to consume because they are needed by the body as a source of vitamins, minerals and fiber. Vitamins and minerals derived from vegetables and fruits have an antioxidant function that can reduce the possibility of non-communicable diseases related to nutrition (Hermina & Prihatini, 2016). Since the COVID-19 pandemic occurred, people have begun to realize the importance of a healthy food. This is indicated by the trend of vegetable consumption which tends to increase every year, although several points showed a decline. Awareness to consume healthy food is proven by the increased consumption of several foods including vegetables and fruit (Mustakim et al., 2021).

West Java is one of the horticultural commodity-producing provinces in Indonesia. A total of 3,250,825 households cultivating horticultural commodities. Cianjur District is one of the locations for the development of fruit and vegetable commodities in West Java. Cianjur District is a location for developing superior vegetables including tomatoes, carrots, green beans, spring onions, and prospective vegetables, namely cayenne pepper and cabbage (Untari et al., 2022). The resulting vegetable production is usually channeled to surrounding areas such as Jabodetabek (Oktafiyanto et al., 2021). Leek has the highest production compared to other commodities, namely 415,210 Kw in 2021. The next highest production is carrots with 395,200 Kw, followed by tomatoes with 362,970 Kw, then beans with 232,485 Kw, cabbage with 137,485, and cayenne pepper with 198,436 (BPS Kabupaten Cianjur, 2022).

Cipanas is one of the sub-districts in Cianjur which is a center for horticultural production, especially vegetables. Vegetables that are mostly cultivated by farmers in Cipanas are pakcoy, spring onions, and carrots. Pakcoy is a vegetable that is liked by many people so that many farmers cultivate it. The problem faced by farmers in cultivating pakcoy is that farmers pay less attention to the level of efficiency in the use of production factors. Farmers have not been able to calculate how to be able to use minimal production factors but can get maximum results.

Pakcoy is in demand by many consumers, which is usually based on the freshness of the pakcoy (Febrianti et al., 2019). Pakcoy's demands are many and scattered and varied in the form of needs and desires (Laili et al., 2021). This is an opportunity for horticultural farmers, especially vegetables, so that in Cipanas District many farmers cultivate pakcoy (Sitepu et al., 2022). Some of the benefits of consuming pakcoy are relieving itching in the throat, curing headaches, purifying blood, improving kidney function, and improving digestion. Pakcoy contains nutrients in the form of carbohydrates, protein, fat, beta-carotene, and vitamins (Hakim & Eko, 2021).

High horticultural production needs to be accompanied by efficient use of production inputs. Efficiency can encourage an increase in production to the income earned by farmers. Technical efficiency is the optimal allocation of production inputs to get the highest output. Economic efficiency is comparing the value of production results to the cost of production inputs used. Horticulture farmers in Cianjur District need to improve efficiency in order to obtain greater profits. Research on the technical efficiency of pakcoy in Cianjur Regency has not been carried out much. This research can be an additional and useful reference for pakcoy

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farmers. Based on this, this study aims to analyze the factors that influence vegetable production and the technical efficiency of pakcoy farming in Cianjur District.

RESEARCH METHODS

The research was conducted in Cipanas Sub-district , Cianjur District, which was chosen because Cipanas is one of the vegetable production centers in Cianjur, West Java. This is also in accordance with the opinion of Mukti et al. (2022) that Cipanas is one of the horticultural agribusiness centers in West Java Province. Quantitative research using the survey method was used in this study from August to November 2022. The data used is primary data obtained from questionnaires distributed to respondents. Respondents in this study were vegetable farmers in Cipanas Sub-district. Simple random sampling was used for sampling to obtain a sample size of 30. The sample size is determined by taking 10% of the total population of 295. Arikunto (2002) stated that if there are less than 100 subjects, it is better to take all of them, whereas if there are more than 100 subjects, 10-15% or 20-25% or more can be taken. Sampling was carried out by drawing lots of names of pakcoy farmers in Cipanas. Baylen (1982) cited by Ruslan (2004) states that one of the requirements for research that uses statistical data to be analyzed is a sample size with a minimum number of 30 respondents. The commodity being analyzed is pakcoy cultivated by the majority of horticultural farmers in Cipanas.

The analytical tool used is multiple linear regression analysis to determine the influence of production factors on the production of pakcoy. The Cobb-Douglass function was used with the following linear equation:

$$\text{Ln } Y = \text{Ln } a0 + b1\text{Ln } X1 + b2\text{Ln } X2 + b3\text{Ln } X3 + b4\text{Ln } X4 + b5\text{Ln } X5 + b6\text{Ln } X6 + b7\text{Ln } X7 + b8\text{Ln } X8 + b9\text{Ln } X9 + b10\text{Ln } X10 + b11\text{Ln } X11$$

Information:

Y	: Production yield (Kg)
a	: Constanta
b1 – b11	: Regression coefficient
X1	: Land area (M^2)
X2	: Seed (Kg)
X3	: Urea Fertilizer (Kg)
X4	: NPK Fertilizer (Kg)
X5	: ZA Fertilizer (Kg)
X6	: Manure (Kg)
X7	: Pesticide Score (ml)
X8	: Supergrow Pesticide (ml)
X9	: Prevathon Pesticide (ml)
X10	: Male Workforce (HOK)
X11	: Female Workforce (HOK)

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Before the f test and t test were carried out, the classical assumption test was performed which includes the normality, multicollinearity, and heteroscedasticity tests. Then the technical efficiency was analyzed using Stochastic Frontier Analysis (SFA) using frontier 4.1 software. The Cobb-Douglass stochastic frontier production function model is:

$$\text{Ln } Y = \text{Ln } a_0 + b1\text{Ln } X1 + b2\text{Ln } X2 + b3\text{Ln } X3 + b4\text{Ln } X4 + b5\text{Ln } X5 + b6\text{Ln } X6 + b7\text{Ln } X7 + b8\text{Ln } X8 + b9\text{Ln } X9 + Vi - Ui$$

Information:
Vi – Ui : Error

The concept of technical efficiency according to Coelly (1995), a farm is identified to be efficient if it has an average technical efficiency value of more than 0.70.

Classical Assumption

Normality test

The normality test was carried out with the aim of testing whether all the variables used are normally distributed. If the pattern is around the diagonal line and follows the direction of the diagonal line, it shows a normal distribution (Ghozali, 2016). Figure 1 shows the pattern formed based on the normality test.

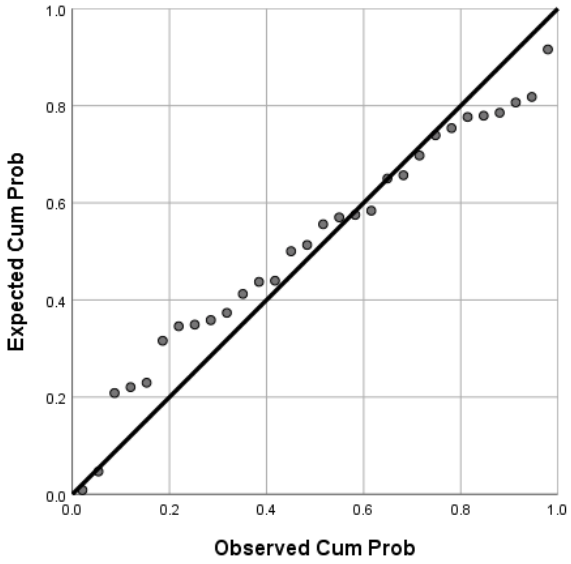

Figure 1.P-Plot Graph
Sources: Processed Primary Data, 2023

Figure 1 shows that the data used in this model forms a pattern following a diagonal line. Regarding Ghozali (2016), these results indicate that the data is normally distributed and meets the assumption of normality.

Multicollinearity Test

The multicollinearity test was carried out to test the correlation between one independent variable and another in the regression model. If the VIF value for the independent variable is greater than 10, then the independent variable has a correlation or multicollinearity

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occurs (Hanum & Sinarasri, 2018). Table 1 presents VIF values based on the multicollinearity test performed.

Table 1. Multicollinearity Test Results

Model	Tolerance	VIF
Land area	.016	62.882
Seed	.026	39.017
Urea Fertilizer	.123	8.106
NPK fertilizer	.238	4.201
ZA fertilizer	.368	2.716
Manure	040	25.124
Pesticide Score	.198	5.048
Supergrow Pesticides	.352	2.841
Prevathon Pesticides	.118	8.480
Male Workforce	.118	8.473
Female Workforce	.102	9.820

Sources: Processed Primary Data, 2023

Regarding the statement Hanum & Sinarasri (2018) the value indicates that the independent variable has high collinearity, that is, if the VIF value is obtained for the independent variable which is greater than 10. Table 1 shows, there are three variables that have a VIF value greater than 10, namely land area, seed, and manure. Therefore, these variables were excluded from the regression model. While other variables have a VIF value of less than 10 and can be used in the regression model.

Heteroscedasticity Test

The heteroscedasticity test was carried out to test the inequality of variance from the residual observation of one other observation in the regression model. Heteroscedasticity does not occur if the dots spread above and below the number 0 on the Y axis and spread without forming a clear pattern. Figure 2 shows the results of the heteroscedasticity test.

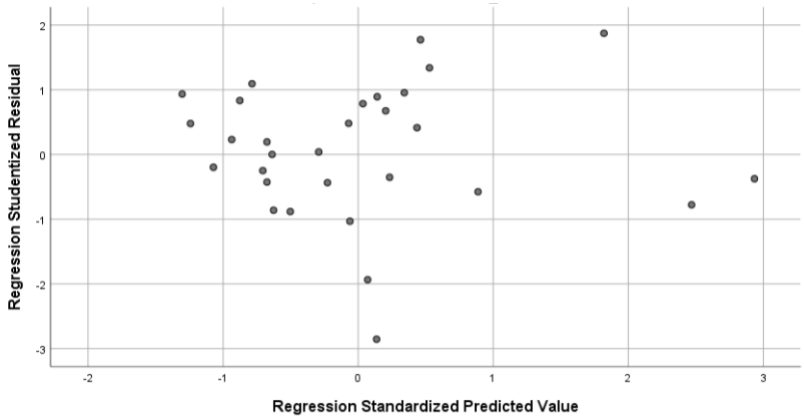

Figure 2. Scatterplot Graph
Source: Processed Primary Data, 2023

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Regarding Figure 2, it can be seen that the dots spread above and below the value 0 on the Y axis and do not form a clear pattern. This means that in this model there are no symptoms of heteroscedasticity so that the model meets the requirements for multiple linear regression analysis. The model equation analyzed by multiple linear regression is:

$$\text{Ln } Y = \text{Ln } a_0 + b1\text{Ln } X1 + b2\text{Ln } X2 + b3\text{Ln } X3 + b4\text{Ln } X4 + b5\text{Ln } X5 + b6\text{Ln } X6 + b7\text{Ln } X7 + b8\text{Ln } X8$$

Information:

Y	: Production yield (kg)
A	: Constanta
b1 – b11	: Regression coefficient
X1	: Urea Fertilizer (kg)
X2	: NPK Fertilizer (kg)
X3	: ZA Fertilizer (kg)
X4	: Pesticide Score (ml)
X5	: Pesticide Supergrow (ml)
X6	: Prevathon Pesticide (ml)
X7	: Male Workforce (man-day)
X8	: Female Workforce (man-day)

RESULTS AND DISCUSSION

Characteristics of Farmers

Characteristics of farmers are characteristics that are usually owned by farmers which consist of several elements that are inherent in the farmer (Subagio & Manoppo, 2016). Characteristics of farmers include age, education, business experience, and number of family members. Farmer characteristics are presented in Table 2.

Table 2 shows that the average age of farmers is 40 years which can be classified as productive age. Economically, productive age is classified into three, namely 0-14 years is not yet productive age, 15-65 years is productive age, and over 65 years is age that is no longer productive (Rusli, 2012). Age can affect the ability of farmers to carry out their farming activities, both physical abilities a nd the ability to be able to absorb information related to technology. Generally, the physical condition of someone who is young is better than someone who is older (Mandang et al., 2020). Age can describe how a person's experience in something (Aisyah, 2013). Someone who is younger may have less experience and skills than someone who is older, but is usually more progressive and willing to take risks (Burano & Siska, 2019). This basically relates to the ability to increase efficiency in business. The experience and knowledge by farmers can be used as capital to increase farming efficiency. Pakcoy farmers in Cipanas sub-district have generally started farming since they graduated from elementary school following their parents. People who are younger generally choose to work in other sectors during their productive years and sometimes return to work in the agricultural sectors.

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Table 1. Characteristics of Farmers

Characteristics	Average	Percentage (%)
Age (years)	40	
Education		
- No school	-	2
- Elementary School	-	66
- Junior High School	-	18
- Senior High School	-	12
- College	-	2
Business Experience (Year)	24	-
Number of Family (Person)	5	-

Sources: Processed Primary Data, 2023

The majority of farmers have elementary school education with a percentage of 66%. Education is related to the mind-set and ability of farmers in running their business. The higher the education, the more rational the farmer's mind-set is and the better able to receive messages (Hikmah et al., 2021). Education is also related to the ability of farmers in business management. The higher the education, the better in implementing business management (Oematan et al., 2020). Good business management can encourage business efficiency so that farmers can optimize their production inputs and get optimal profits. Relatively low education among farmers was caused by a lack of awareness of the importance of education at that time. Economic problems are also the reason why many farmers do not continue their education to a higher level. Nowadays, people are becoming more aware of the importance of education. So it can be seen that education is in line with the age of the farmer, relatively old farmers generally have low education and young farmers have higher education.

The average experience of farmers in horticultural farming is 24 years. The longer the business experience, it can affect the progress of the business being run (Imtihanah et al., 2018). Business experience is one of the factors that influence business success. The longer a person's business experience, the more able to increase the productivity of his business (Khasanah, 2016). Business experience influences business management and decision making in various aspects including increasing the efficiency of farming (Saqib et al., 2018). With an average age of 40 years, farmers generally have relatively long business experience in horticultural cultivation. Most of the farmers started working as farmers when they graduated from elementary school.

Farmers have a number of dependents with an average of 5 people. The number of family dependents can be influenced by geographical, educational, and cultural aspects (Purwanto & Taftazani, 2018). The large number of family dependents certainly requires the farmer as the head of the family to be able to earn more. This can encourage farmers to find ways to maximize their farming activities, one of which is by increasing business efficiency. In addition, if the income obtained through farming activities cannot meet all the needs of his family, farmers will look for other sources. Pakcoy farmers in Cipanas District usually have other sources of income, from being laborers or entrepreneurs. Farmers also sometimes minimize spending so that it is not too high and only focuses on the most important needs.

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The Influence of Production Factors on Pakcoy Production Simultaneously

The influence of production factors on pakcoy production was simultaneously tested using the F Test. ANOVA tables are used to see the significance value needed in decision making in the F Test (Rakasyifa & Mukti, 2020). The decision rule based on the results of the F test is if the significance value is <5% (alpha) then reject H0. Statistical hypothesis for the f test on namely:

H_0: $\beta = 0$: Urea fertilizer, NPK fertilizer, ZA fertilizer, Score pesticide, Supergrow pesticide, Prevathon pesticide, male workforce and female workforce have no significant effect on simultaneous production

H_1: $\beta \neq 0$: Urea fertilizer, NPK fertilizer, ZA fertilizer, Score pesticide, Supergrow pesticide, Prevathon pesticide, male workforce, and female workforce have a significant effect on production simultaneously

The F test was carried out with the IBM SPSS 26 tool presented in Table 3.

Table 2. F Test Results

Model		Sum of Squares	Df	MeanSquare	F	Sig.
1	Regression	26,089.505	8	3,261.188	24,454	.000b
	Residual	1,982.205	21	133.362		
	Total	28,890.099	29			

*Sig. (0.000) < α (0.1) => Reject H_0

Sources: Processed Primary Data, 2023

Regarding the results of the F test in Table 3, the decision obtained is to reject H0, which means that simultaneously the independent variables/production factors include Urea fertilizer, NPK fertilizer, ZA fertilizer, Score pesticide, Supergrow pesticide, Prevathon pesticide, male worker, and female worker have a significant effect on pakcoy production. If farmers pay attention to all of these production factors together as a whole, it can have a significant influence on the resulting pakcoy production. Technical efficiency in farming can be achieved when farmers pay close attention to all production factors and make optimal use of them.

The Influence of Production Factors on Pakcoy Production Partially

The influence of production factors on pakcoy production was partially tested using the T test. The statistical hypothesis for the t test is as follows:

H_0: $\beta = 0$: Urea fertilizer, NPK fertilizer, ZA fertilizer, Score pesticide, Supergrow pesticide, Prevathon pesticide, male workforce, and female workforce have no significant effect on production partially

H_1: $\beta \neq 0$: Urea fertilizer, NPK fertilizer, ZA fertilizer, Score pesticide, Supergrow pesticide, Prevathon pesticide, male workforce, and female workforce have a significant effect on production partially

The T test was carried out using the IBM SPSS 26 tool presented in Table 4.

Table 3. T Test Results

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Model	Unstandardized Coefficients		Standardized Coefficients	Q	Sig.
	B	std. Error	Betas		
(Constant)	-19,154	14,516		-1,320	.201
Urea Fertilizer	9,613	6,949	.223	1,383	.181
NPK fertilizer	-.066	.170	-.051	-.388	.702
ZA fertilizer	-.254	.143	-.170	-1,782	089
Pesticide Score	.222	077	.402	2,905	008
Supergrow Pesticides	054	092	.064	.589	.562
Prevathon Pesticides	.023	039	.097	.587	.563
Male Workforce	18,426	14,189	.207	1,299	.208
Female Workforce	7,495	5,095	.251	1,471	.156

Sources: Processed Primary Data, 2023

Regarding the results of the T test in Table 4, after comparing the significance value with the alpha value (0.1) it is known that the variables that have a significant effect are ZA fertilizer and score pesticide. The significance value of this variable is less than 0.1, so the decision is to reject H . ZA fertilizer and Score pesticide have a significant effect on the production of pakcoy cultivated by farmers. Meanwhile, other variables have a significance value greater than 0.1, so the decision is to accept H_0, which means that partially these variables do not have a significant effect on the production of pakcoy commodities. In line with research Lulu (2022) which stated that urea fertilizer, NPK fertilizer, and labor had no effect on pakcoy production. Urea fertilizer has no effect on production, which can be caused by less than optimal use. Urea fertilizer is a hygroscopic fertilizer or easily attracts moisture and can scorch plants if used excessively. The use of NPK fertilizers usually does not pay attention to the appropriate dosage and causes sub-optimal effects. The workforce employed in cultivation activities is sometimes not in accordance with the needs whether there is a shortage or excess of labor.

Regarding the results of the analysis, the factor coefficient of production of ZA fertilizer is positive, which means that the influence of the production factor of ZA fertilizer on pakcoy production is a positive influence. This means that the higher the use of ZA fertilizer, the higher the production of pakcoy. However, in the farming concept, the use of fertilizers, including in this case, ZA fertilizer must be used optimally and not too much. This is caused by the existence of The Law of Diminishing Product which can result in production actually decreasing if production factors are continuously added and it becomes inefficient. ZA fertilizer has an effect in the form of accelerating metabolism and influencing the growth of organs such as stems, leaves and roots for the better (Pangestu et al., 2022). Farmers basically do not understand this concept well, so sometimes the use of ZA fertilizer does not suit their needs. Therefore it is necessary to provide education regarding the proper use of fertilizers and other production factors according to the needs of the pakkcoy plant.

The regression coefficient on the Score pesticide variable is positive so that the influence given by business experience to the resulting pakcoy production is a positive influence. This means that the higher the use of pesticide Score, the higher the pakcoy production. As with the use of fertilizers, the use of pesticides must also be used optimally and

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not excessively. Even though pesticides have a positive effect, their use must still be limited and adjusted according to the needs. In line with research by Lulu (2022) which stated that pesticides have a significant effect on pakcoy production. Farmers use pesticides according to the procedures and needs of the pakcoy plant. However, sometimes farmers still give doses that are not in accordance with plant needs due to a lack of knowledge about the concept of efficiency. The equation formed from this regression model is:

$$Y = -19.154 + 9.613X1 - 0.066X2 - 0.254X3 + 0.222X4 + 0.054X5 + 0.023X6 + 18.426X7 + 7.495X8 + \varepsilon i$$

The above equation describes the relationship between the independent variables and the dependent variable. The relationship that occurs can be a positive relationship and also a negative relationship. The positive relationship illustrates that if there is an increase in the independent variable, the dependent variable will also increase. Then the negative relationship illustrates that if there is an increase in the independent variable, the dependent variable will decrease and vice versa. Production factors that have a positive effect are urea fertilizer, Supergrow pesticides, Prebathon pesticides, male and female workers. While the production factors that have a negative influence are NPK fertilizer and ZA fertilizer. Several factors of production that have a positive influence must still be used as needed and there is a maximum usage limit. If the factors of production are added continuously, it will actually reduce production.

Coefficient of Determination (R2)

The coefficient of determination is an indicator that is able to describe how much variation is described in the model. Regarding the value of the coefficient of determination obtained, it can be seen the level of significance or suitability of the relationship between the independent variable and the dependent variable (Sinambela et al., 2014). The coefficient of determination (R Square) in this model is presented in Table 5.

Table 5 shows that the R Square value obtained is 0.903 or 90.3%. This illustrates that the independent variables used in this study can explain the results of pakcoy production as much as 90.3%. Then the remaining 9.7% is explained by other variables that were not examined in this study.

Table 4. Summary Models

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.950[a]	.903	.866	11.54823	1,752

Sources: Processed Primary Data, 2023

Pakcoy Farming Technical Efficiency

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Technical efficiency was analyzed using Stochastic Frontier Analysis (SFA) with Frontier 4.1 tools. The frontier function is used because it can describe the actual state of efficiency in the field. Regarding the concept of technical efficiency of Coelly (1995), a farm is identified to be efficient if it has an average value of technical efficiency of more than 0.70. The results of the technical efficiency analysis are presented in Table 6.

Table 5. Distribution of Pakcoy Farming Technical Efficiency Levels

Index	Amount	Percentage (%)
0.00 – 0.10	0	0.00
0.10 – 0.20	0	0.00
0.20 – 0.30	0	0.00
0.30 – 0.40	0	0.00
0.40 – 0.50	1	3,33
0.50 – 0.60	0	0.00
0.60 – 0.70	0	0.00
0.70 – 0.80	6	20.00
0.80 – 0.90	8	26,67
0.90 – 1.00	15	50.00
Total	**30**	**100.00**
Average	**0.89**	
Max	**0.99**	

Sources: Processed Primary Data, 2023

Table 6 showed that 96.67% of pakcoy farming in Cipanas can be identified in the efficient category because it has an efficiency value greater than 0.70. If seen based on the average, an index of 0.89 is obtained, which means that pakcoy farming in Cipanas can be declared technically efficient. The use of production factors can be increased to a certain level in order to achieve efficiency at number 1 (Lulut, 2022). Farmers usually use production factors according to their habits or based on information from other Pakcoy farmers. Farmers optimize the use of fertilizers and pesticides in their cultivation activities. However, there are several factors of production whose quality is not given much attention, such as seeds and labor. Even so, the average pakcoy farmers are included in the efficient category. If farmers understand the concept of technical efficiency in detail, then efficiency can be increased and can increase income for farmers.

Efficiency can be increased by adding the quantity of several production factors that are positively related to production, as well as reducing the use of production factors that have a negative relationship with production. Of all the farmers, there is one farmer who has an efficiency level of less than 0.70. Increasing efficiency can also be done by providing training for farmers. Information on how to achieve efficiency and its practices needs to be informed so that farmers understand the concept of efficiency and can apply it in their farming activities. The government and other parties can carry out programs such as the use of superior variety seeds, the use of appropriate fertilizers and pesticides, and others.

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CONCLUSION AND SUGGESTION

The production factors that have a significant influence on the production of pakcoy in Cipanas Sub-district, Cianjur District are ZA fertilizer and Score pesticide. Technically, pakcoy farming in Cipanas is classified as efficient. The author has a suggestion for farmers to pay attention to all production factors used and not to use them excessively. Technical efficiency can be further improved by optimizing the use of the necessary production factors in order to obtain maximum results. Farmers can take part in training on increasing technical efficiency in order to understand the concept of technical efficiency. Farmers can then practice the concepts they understand regarding technical efficiency in pakcoy farming.

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