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TECHNICAL EFFICIENCY OF RICE FARMING AROUND THE NICKEL MINING IN KONAWE SELATAN DISTRICT

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ABSTRACT

South Konawe Regency has vast potential agricultural land, It can support the regional economy by supplying the food needs of the community and being a major player in trade across districts. In addition to providing food, the agricultural sector also serves as a market for goods produced by the industrial sector in rural communities and urban areas, a source of labor for industry, a source of capital for modern economic growth, particularly in its early stages, and a source of foreign exchange. Policy support is needed from the government in developing the agricultural sector considering the importance of synergy between the agricultural and mining sectors to minimize negative impacts in order to achieve economic balance so that it becomes the basis for local governments in taking appropriate policies to support the agricultural sector amidst mining activities. The purpose of this study is to examine lowland rice farming's technical effectiveness and production characteristics in the vicinity of South Konawe Regency's nickel mine. The data collected used primary and secondary data, with a total of 20 farmers as respondents. Stochastic Frontier Analysis (SFA) was utilized to analyze the data. The findings of the study indicate that lowland rice farming is technically efficient when it is conducted near nickel mining and that the production elements that actually affect lowland rice farming include land area, labour force, urea and NPK fertilisers, and insecticides.

Keyword: Agricultural, Business, Education, Production, Sector

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INTRODUCTION

The production of food is mostly dependent on the agriculture industry's major part in providing food to realize food, security, social, economic, and political, and providing raw materials for the needs of a country. Along with the increase in population, the need for agricultural products is also increasing (Sarlan, 2020). For a long time, the agricultural sector has been the most important in the history of Indonesia's development to reduce poverty both directly and indirectly, especially in improving the welfare of farmers (Ma'ruf et al., 2019)

One of the agricultural subsectors that supports the development of the agricultural economy is food crops (Khairad et al., 2018). Rice is a growing food commodity. Government efforts to increase rice production are important in line with population growth and the food industry (Aprianti et al., 2020).

A farmer's technical efficiency is their capacity to yield the highest possible crop with a given quantity of inputs. Farmers are deemed technically efficient When they maximize their output through optimal use of inputs. Technical efficiency looks at the relationship between inputs and outputs, regardless of input or output prices (Khomsah et al., 2022). One indicator that causes inefficient Rice Farming is low productivity. Low agricultural productivity is caused by inefficient agricultural production, which is caused by the misallocation of production factors (Rachmawati et al., 2022).

Farming is the process of production activities to obtain results and obtain income from farming. Agricultural activities first of all incur production costs to obtain products and sell them for income (Sadat et al., 2023). Farmers need to take the appropriate precautions when producing for maximum productivity At an optimal production level, maximum profit is realized (Arifin et al., 2019). Given the high ratio of income to farm expenses, farmers' income should be sufficient to fund good farming practices. A location with a high feasibility ratio is predicted to see an improvement in rice paddy income levels (Nearti et al., 2020). One of the Indonesian provinces with significant nickel deposits is Southeast Sulawesi. Various licensing problems occur in Southeast Sulawesi starting from overlapping permits and forest areas, disclosure of permit information, and weak community participation and supervision of mining activities. Problems that often arise in the exploration and exploitation of mineral resources occur in Environmental Quality including soil degradation, air pollution, and hydrological damage to water (Ahmada & Sarifudin 2023).

Farmers perception of the existence of mining activities is a cognitive process experienced by the community in understanding information about the existence of mining activities in the area (Rinaldy et al., 2020). However, most farmers are unaware (do not know and/or understand) of the long-term effects of mining (Demmallino et al., 2018). Referencing information from the Mineral Resources and Energy Ministry (ESDM, 2023) the number of mining business permits (IUP) in Southeast Sulawesi reached 261 permits, which are divided into 256 IUP, 1 IUPK, 1 WIUP, 2 WIUPK, and 1 KK spread across several regencies, one of which is South Konawe Regency.

South Konawe Regency is one of the areas with quite large nickel mining activities in Southeast Sulawesi. Based on data from the Director of Mining Companies in Southeast Sulawesi until 2022, there are 213 mining firms in Sulawesi southeast, 143 businesses are nickel businesses or around 67% of the total existing mining companies. Nickel mining can significantly impact the environment and surrounding agricultural activities, including farming, when the mud material from nickel mining sites affects irrigation water quality and reduces soil fertility as a result of nickel mining operations (Maga, 2022). South Konawe Regency is also the second area with the largest harvest area after Konawe Regency, namely 22,705.43 Ha. However, it has a low productivity of 36.94 ku/Ha and production of 36.94 ku/Ha and 83 864.92 tons compared to East Kolaka which only has a harvest area of 19 547.25 Ha which has a productivity of 46.69 Ku/Ha and production of 91 262.65 tons (Tenggara, 2022). This proves that South Konawe Regency is an area with great potential in agriculture, especially rice fields. Rice is the main food commodity in this region, so analyzing the impact of nickel mining on rice farming is very important to ensure food security and maintain farmer welfare, even though mining activities occur. Research on the effects of nickel mining on rice farming production and income in mining locations is necessary because these effects can be either positive or negative (Hasriati et al., 2019).

Identify challenges and opportunities in balancing mining activities with sustainable rice farming. Supporting food security and the well-being of farmers in the areas under study requires this. It is anticipated that this study will significantly expand the body of knowledge that can be utilized by policymakers and stakeholders in managing land use optimally and mitigating potential conflicts between the mining and agricultural sectors. Furthermore, This study attempts to fill the disparity between the scientific literature concerning the impact of mining activities on rice farming, a study area that is still limited in scope, as stated by (Nursalam & Aldiansyah, 2019). Based on these considerations, researchers consider it urgent to carry out an empirical study in Mondoe Village, South Konawe Regency, Southeast Sulawesi Province.

Based on the mining activities that occur in Mondoe Village, South Konawe Regency, Southeast Sulawesi Province, and the impacts faced by farmers such as environmental impacts and the start of land constriction around mining, the problem formulation in this research is whether rice farming around nickel mining in Konawe Regency The South is still profitable and still technically efficient. This study aims to examine the production variables and technological efficiency of rice farming near nickel mining in South Konawe Regency. The results of this study are expected to provide a comprehensive understanding of the dynamics that affect the income of farmers who depend on the agricultural sector in areas affected by mining activities, develop strategies and optimize the interaction of the two sectors to realize a sustainable economic balance, taking into account the interests of various stakeholders and long-term ecological aspects. So that it can be a basis for formulating more effective and sustainable policies.

RESEARCH METHODS

Time and Location of Research

This study was carried out in the South Konawe Regency's Mondoe Village, South Palangga District, Southeast Sulawesi Province. Purposive sampling was used to carefully choose the research locations, taking into account that the South Palangga sub-district, with a distribution of 10 points spanning 289.85 Ha, is among the areas with the second largest distribution of nickel openings, after the Laeya sub-district. (Sufrianto et al., 2019) One of the settlements bordering Torobulu Village is Mondoe Village, Laeya subdistrict, which is the location of nickel mining activities that are still actively operating, and the majority of the Mondoe village community are rice farmers and receive the impacts of nickel mining.

Method of Collecting Data

Both primary and secondary data are used in this study. Direct interviews with rice farmers around the mine, who were directed by questionnaires, provided primary data. while secondary data is data or information that has been documented in the form of statistical data or research results obtained from organizations or institutions related to this research.

Sampling Method

The respondents in this research were rice farmers around nickel mining in South Konawe Regency. In this study, all population members were used as samples using the Saturated Sampling Technique. The number of samples used within this research was all farmers in Mondoe Village, South Palangga District, namely 20 people.

Data Analysis

Analysis of Stochastic Frontier Production Functions

To quantify and evaluate the technical efficiency of production of rice cultivation on the input side, one can utilize stochastic frontier production function analysis, farming simultaneously by the objectives of this research. After being tabulated in Microsoft Excel, the gathered data was processed with the SPSS 23 and Frontier 4.1 software. The rice production role in this study uses the stochastic frontier production function (Coelli et al., 2005).

The initial estimation method for the stochastic frontier production function using the Cobb-Douglas production function is determined by the ordinary least squares (OLS) method, so several OLS assumptions must be used in testing the feasibility of the model. OLS estimates the parameter βi using SPSS 23 software to check for violations of assumptions (multicollinearity, autocorrelation, and heteroscedasticity), production is not present in the estimated model. The suitability of the estimation model to the data used (goodness of fit) was tested based on the coefficient of determination and the significance of the estimation parameters together. If the hypothesis is accepted, then the average production model is quite representative.

The equation model for estimating The production function of rice cultivation with the stochastic frontier in this research, namely farmers who cultivate rice in paddy fields that are not affected and those who are affected by nickel mining, can be written as follows:

$$LnY = \beta_0+\beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \ldots\ldots + \beta_6 lnX_6 + v_i - u_i \ldots\ldots\ldots(1)$$

Where:

Y = Rice production (Kg)
X_1= Land area (Ha)
X_2 = Number of seeds (Kg)
X_3 = Number of workers (HOK)
X_4 = Amount of Urea fertilizer (Kg)
X_5 = Amount of NPK fertilizer (Kg)
X_6 = Amount of pesticide (l)
B_0 = Intercept
Bi = Coefficient of production factor i
Vi-ui = Error term (vi is the noise effect, and UI is the technical inefficiency effect in the model)

The expected coefficient values are 1, 2, 3,…, 6, > 0. An increase in inputs such as land, seeds, labor, urea fertilizer, NPK fertilizer, and organic fertilizer is anticipated to boost rice output when the coefficient value is positive. The remaining variable (random shock) vi is a variable with the same distribution (i.i.d) with a mean value of zero and constant variance and is free from us. The error variable (residual solow) ui is a variable used to characterize technical production inefficiencies. The error variable ui is assumed to be freely distributed between each observation and the value vi. The ui variable cannot have a negative value and its distribution is half normal (half normal distribution) with its distribution value (Coelli et al., 1998).

Analysis of Technical Efficiency and Effects of Technical Inefficiency

You can use the following formula to calculate technical efficiency analysis:

$$TE_i = \exp\ |(-e[u_i\ |\varepsilon_i])\ i = 1,2,3,\ldots, N \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

exp (-E [ui|εi]) is the expected value (mean) of ui under the condition εi, where TEi is the technological efficiency of farmer i. As a result, 0 < TEi ≤ 1. Technical efficiency is only utilized for functions with a fixed number of inputs and outputs (cross-section data), and its value is inversely proportional to the effect of technical inefficiency.

This study's technical efficiency approach makes use of the technical inefficiency impacts model that was created by Coelli (1998). Technical inefficiencies are measured using the UI variable. Calculating the distribution parameter value (ui) of the effects of the technological inefficiency of the researcher, namely the rice farms that are unaffected by nickel mining and those that are. The subsequent formula was applied in this study::

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \ldots + \delta_6 Z_6 + \varepsilon_i$$

Where:

ui = Technical inefficiency effect
δ = Expected coefficient value; It is assumed that δ1 and δ3 > 0 while δ2, δ5, δ6, and 7, < 0.
Z_1 = KK's age (years)
Z_2 = KK formal education (years)
Z_3= Farming experience (years)
Z_4 = Number of family dependents (people)
Z_5 = Dummy seed (1=labeled seed, 0=unlabeled)
Z_6 = Training frequency (per growing season)
Z_7 = Land processing dummy (1=tractor, 0=others)

The variables above are determined based on issues and interests that can be raised in rice policies related to increasing production through efficiency.

The expected coefficient values δ1, δ2, δ3, δ4, δ5, δ6, and δ7 < 0. The coefficient values are positive, meaning that increasing input usually increases rice production. The resulting estimation model will use the estimated Maximum Likelihood Estimation (MLE) parameters. If H0: ɤ = δ1, δ2, δ3, δ4, δ5, δ6, and δ7 = 0, this means that the effect of technical inefficiency does not exist in the production function model. If this hypothesis is accepted, then the average production function model is sufficient to represent the empirical data. The ɤ value is the contribution of technical efficiency to the total residual effect.

Using the frontier 4.1 software, the parameters for calculating the inefficiency function and stochastic frontier production function (SFPF) were estimated concurrently. (Coelli, 1998). Two phases of testing were conducted to determine the stochastic frontier parameters and technological inefficiency impacts. In the first step, all parameters (β0, βi, variations ui, and vi) are estimated at a maximum confidence level of ˆ= 15 percent using the Maximum Likelihood Estimation (MLE) approach. The second stage is estimating the parameter βi using the OLS method using SPSS 23 software to check for violations of assumptions (multicollinearity, autocorrelation, and heteroscedastic). Children's processing findings from the Frontier 4.1 software, according to Coelli et al. (1998), offer parameterizations that represent estimations of the variance of the parameters.

Since the variance's parameter can determine γ, its value falls between 0 and 1. The technical efficiency's contribution to the overall residual effect is represented by the parameter value of γ. When the value of γ approaches zero, it is considered that noise (vi), which includes weather, pests, and other external factors, is the cause of all errors. Also, if the γ value is near to 1, it indicates that noise (vi) is not the source of the stream error; rather, it stems only from inefficiencies (UI). Additionally, estimations of the log-likelihood and Σ2 values are produced by the Frontier 4.1 program's processing results. It is necessary to compare the log-likelihood value obtained from the OLS approach with the log-likelihood value obtained from the MLE method. The production function utilizing the MLE approach is good under field conditions if the log-likelihood value obtained through the method is larger than that obtained through OLS. The distribution of tram inefficiency errors (UI) is displayed by the Σ2 value. A little value indicates that (UI) is spread normally.

RESULTS AND DISCUSSION

General Description of The Research Location

Astronomical South Konawe is located between 30,58.560 and 4,031.520 South latitude, and between 121.580 and 123.160 East longitude. Based on position Geographically, South Konawe has boundaries: North-Konawe and Kendari City; East-Banda Sea and Maluku Sea; South-Bombana and Muna;

West-Regency Kolaka. Land area South Konawe, 451,420 Ha or 11.83 percent from land area Southeast Sulawesi Province. Whereas water area (sea) ± 9,368 km^2. Besides the peninsula of southeast Sulawesi Island, there are also islands small that as Hari Island and Island Cempedak. By administration, Regency South Konawe in 2013 consisted of over 22 sub-districts namely 1) District Andoolo, 2) Buke District, 3) District Angata, 4) District Kolono, 5) Konda District, 6) District Lainea, 7) District Landono, 8) District Laonti, 9) District Moramo, 10) District Palangga, 11) District Ranomeeto, 12) District Tinanggea, 13) District Lalembuu, 14) District Baito, 15) District Continent, 16) District Basala, 17) District Mowila, 18) District West Ranomeeto, 19) District Wolasi, 20) District Laeya, 21) District South Palangga and 22) District North Moramo.

Regency South Konawe, the mother of the city Andoolo, is geographically situated in the southern region of the Equator, specifically between latitudes 3°.58.56' and 4°.31.52' north to south, and between longitudes 121.58 and 123.16 east, longitudinally from west to east. Land area Regency South Konawe, 451,420 Ha or 11.83 percent of the land area of Southeast Sulawesi. Whereas water area (sea) ± 9 368 Km2. Besides the peninsula of southeast Sulawesi Island, there are also islands small that is Island Cempedak. Based on the District's data, Subdistrict Tinanggea 37,904 Ha (8%) has the greatest area, followed by Subdistrict Lalembuu (7%) and District Landono, Konda, and Moramo (6%) with sub-districts having smaller areas than 6 percent. Subdistrict South Palangga, which makes up only 3% of its total area, is the smallest district.

The majority of surface land is steep and rugged, with lowlands on either side that have very little potential for agricultural development. Based on the height line according to the results of District area research South Konawe can differentiated into 5 classes according to height, mapping is also carried out to classify slope and type of land. Latosol accounts for 105,451.7 Ha, or 23.36 percent, of the type land in the Regency South Konawe; Podzolic accounts for 127,074.7 Ha or 28.15 percent; Organosol, for 21,261.8 Ha, or 4.71 percent; Mediterranean, for 15 303.1 Ha, or 3.39 percent; Alluvial, for 21 668.16 Ha, or 4.80 percent; and land mixture, for 160,660.3 Ha, or 35.59 percent. Regency South Konawe has several rivers, including the Lapoa, Laeya, and Roraya rivers, that are large enough to support the growth of agriculture, 25 irrigation systems, and the production of electricity. rice fields irrigated by a dam on the Continent Aporo ± 2 602 Ha.

Regency South Konawe is one of the provinces of Southeast Sulawesi's rice barn areas. Of its 451 185 Ha land area, 430,650 Ha (or 95.45%) are land dry, while the remaining 20,535 Ha (or 4.55%) are rice fields. Condition plant-developed food is rice, corn, soybeans, cassava, sweet potatoes, beans soil, and nuts green. Of the 20,535 Ha, 6 610 Ha (32.2 percent) of rice fields are irrigated rice fields villages 5,169 Ha (25.2 percent) of cistern rice fields rain, and 4 547

Ha (22.1 percent) of irrigated rice fields half technical, 3,165 Ha (in the form of irrigation simple and 594 Ha (3 percent) of irrigated rice fields technical. There are few irrigated rice fields technical or half-technical This will impact a variety of things timetable plants in each region in the Regency Konawe Salatan. Rice productivity was only 7 tonnes/ha, not nearly enough. Ciherang, Cisantana, Ciliwung, Cigeulis, Mekongga, and Way Apo Buru are the types that are frequently utilized.

Subdistrict South Palangga is one of the Districts in Regency South Konawe with capital Amondo, literally geographically located in the southeastern part of the capital Regency. Land area Subdistrict South Palangga, namely 12 085 Ha or 2.68 percent from wide mainland Regency South Konawe. District boundaries South Konawe, namely to the north of the border with Subdistrict Palangga, south of the border with Strait Tiwoto, west of the border with Subdistrict Tinanggea, and the east border with Subdistrict Laeya. Topography, The majority of the territory is steep and mountainous, with very little potential for the growth of plantations, farms, fisheries, or other enterprises. 26 Districts South Palangga has sufficient rice fields wide, needs Good irrigation is very necessary to increase the production. By general irrigation of rice fields is irrigation half technical. Use land consists of land rice field farming 182,2 Ha, land agriculture dry (lakes, community plantations, ponds).

Mondeo Village occupies 939 km^2 and is one of the settlements in the South Palangga District. Wawowonua Village borders Mondoe Village to the north; the Banda Sea borders it to the south; Torobulu Village borders it to the east; and Parasi Village borders it to the west.

Characteristics of Farmers

The features of the respondents in this study are employed as predictors of the technical efficiency of rice growing. A few of the attributes under consideration are age, level of formal education, and prior farming experience.

Farmer Age

One of the things that can influence one's physical capacity for work and thought is age. Generally, someone who is younger has a better ability to do physical work compared to someone much older. A younger farmer tends to be more dynamic and innovative in managing his/her farming business. However, generally, older farmers usually have enough experience so that they are skilled in farming. Production and non-production categories are the basis for age grouping. For more details about the characteristics of respondent farmers according to age level, see Table 1.

Table 1. Respondent Distribution based on Their Age Groups

Age (years)	Number of Respondents (people)	Percentage (%)
10-24	4	20
35-49	12	60
50-64	3	15
≥65	1	5
Amount	20	100

Source: Primary Data (2023)

Table 1. demonstrates that 19 respondents, or 95% of the rice farmers around the nickel mine, are of productive age, whereas 1 respondent, or 5%, is of less productive age. With these conditions, it can be said that the respondents of rice farmers around nickel mining are respondents of productive age, namely 24-64 years old. Based on this, with productive age, farmers are more effective and efficient in farming.

Formal Education of Farmers

Formal education is a process that can increase and improve a farmer's knowledge and influence the way a farmer thinks. The ability of farmers and the decisions they make in managing their farming business are highly dependent on their degree of education. In general, a low degree of education not only causes farmers to lack understanding of information regarding innovations in their business but can also make it difficult for farmers to accept what is recommended. On the other hand, farmers with higher education have more knowledge and broader thinking so they can accept new recommended technology more quickly and are better at making decisions. Those with greater educational attainment, the more efficient he or she is at working and making decisions. An increased level of knowledge increases the likelihood that a farmer will be able to make better decisions and operate their farm more efficiently. See Table 2. for further information on farmers' levels of formal education.

Table 2. Respondent Distribution based on Their Level of Education

Formal Education (Years)	Number of Respondents (People)	Percentage (%)
No school	2	10
SD	10	50
SMP	6	30
SMA	2	10
Amount	20	100

Source: Primary Data, 2023

Table 2. reveals that of the respondents who are rice farmers near nickel mining, fifty percent have completed elementary school. The description above shows that most respondents of rice farmers around nickel mining only have a formal education at the Elementary School level, so it is hoped that the increasing number of educated farmers, will make it easier for themselves and community groups to receive information or knowledge from various sources of information that can provide added value in developing their farming businesses, with adequate education can positively influence the productivity of their farming enterprises.

Farming Experience

Respondents of rice farmers consist of several categories when measured by farming experience. There exist farmers with fewer than five years of experience farming rice, farmers with twenty years of experience cultivating rice, and farmers with more than twenty years of experience farming rice. For more details about the farming experience of rice farmers on land affected and land not affected by mining, see Table 3.

Table 3. Farming Experience

Age (years)	Number of Respondents (people)	Percentage (%)
≤ 05	4	20
6-10	7	35
11-20	8	40
21-30	1	5
Total	20	100

Source: Primary Data, 2023

Table 3. displays the responses from rice farmers who live close to the nickel mine, most of the farmer respondents have 11-20 years of experience, namely 8 people or 40 percent of respondents. And those who have 21-30 years of experience are only 1 person or 5 percent. And there are no respondents who have experience over 25 years. Thus it can be seen that most of the farmer respondents have a lot of experience. The longer the experience in farming, the more experience they gain, this affects the efficiency of farming.

Number of Dependents in the Family

One of the labor variables for respondents is the number of family dependents. The family dependents referred to are all family members, both under one roof and not under one roof, whose lives are supported by the head of the family. The number of responder family members affects how much of the needs in the household will be carried by the head of the family.

Furthermore, the number of family members might have an impact on the profitability and effectiveness of the rice farming enterprise that is held. Table 4. provides further information about the number of rice farmer respondents' family dependents who are impacted by mining and who are not.

Table 4. Respondent Distribution based on Family Size

The Number Of Dependent Family Members (Persons)	The Number Of Participants (People)	Percentage (%)
1-2	3	15
2-4	14	70
5-6	3	15
Total	20	100

Source: Primary Data, 2023

Table 4. reveals that the majority of rice farmers surveyed near the nickel mine had family dependents with two to four members, accounting for seventy percent of the total. Those with one to two and five to six members each make up fifteen percent of the sample. This indicates that a large percentage of respondents have many family members in the tiny category. A family's ability to allocate its income in a way that provides for both consumption and other interests will be positively impacted by the number of family members in the smaller group.

Factors Affecting Rice Production Around Nickel Mining

The MLE (Maximum Likelihood Estimation) model is used in estimating the production function because it has a log-likelihood function value that is greater than the OLS (Ordinary Least Square) model so that the production function obtained becomes more accurate, including in determining the factors that affect rice production around nickel mining (Devlieger and Rosseel 2020); (Mazucheli, et al 2018). In addition, the MLE model is advantageous as it allows for the inclusion of additional variables and their respective coefficients, such as soil quality and rainfall, which are crucial factors in rice production. This enables a more comprehensive analysis and understanding of the impact of nickel mining on rice production. Moreover, the MLE model accounts for potential heteroscedasticity and non-linearity, making it suitable for capturing the complex relationship between the factors and rice production in the context of nickel mining. The findings demonstrated that the amount of urea fertilizer, TSP fertilizer, land area, labor force, and pesticides all have an impact on the rise in rice production.

Land Area

At a 95% confidence level, the land area used for rice growing adjacent to mining has a true beneficial effect, with a production elasticity of 0.60. Assuming ceteris paribus, a 10% increase in land area will result in a 6.0% increase in rice production. This finding suggests that expanding the land area dedicated to rice farming in proximity to mining operations can significantly contribute to boosting rice production (Novikarumsari et al., 2020);(Amiruddin et al., 2023) However, it is important to note that this positive effect is contingent upon maintaining all other factors constant, such as technological advancements, weather conditions, and labor availability. According to research by Ifgayani et al. (2019), labor and land area are the two factors that affect rice output. Next, Andrias et al. (2017) claimed that land area had a positive and significant impact on farmers' income and productivity, while Putri et al. (2020) concluded that land area had a positive and significant effect on rice production, i.e., the more rice produced, the larger the land area. Thus, land area is an indicator that greatly influences production.

Countries with larger land areas often possess more extensive agricultural spaces, which facilitate increased crop yields and production due to the potential for economies of scale, diverse crop rotation, and advanced mechanization. Empirical studies indicate that countries like the United States and Brazil, with their vast arable land, consistently rank among the highest in agricultural output globally. Furthermore, larger land areas enable extensive natural resource extraction activities, such as mining and forestry, which are crucial for economic growth. For instance, Russia and Canada leverage their substantial land masses to harness vast mineral reserves and forest resources, contributing significantly to their GDP and providing raw materials for global markets. Therefore, policymakers and businesses must integrate land area considerations into their economic assessments to optimize land use planning, infrastructure development, and sustainable resource management. This strategic approach ensures that the economic potential and productivity of a region are maximized while mitigating environmental impacts and fostering long-term sustainability. Table 5 displays the output of the production function estimation.

With an elasticity of 0.02, seeds have no discernible impact on output. In other words, assuming ceteris paribus, a 10% increase in the quantity of seeds will result in a 0.02% increase in productivity. But it's crucial to remember that other elements like soil quality, climate, and agricultural practices can all have an impact on how seeds affect output. Additionally, while a 10% increase in seeds may only result in a 0.02% increase in production, it is possible that a higher percentage increase in seeds could have a more significant effect on overall productivity. Thus, to maximize their agricultural methods, farmers need to take a comprehensive approach. According to studies carried out by (Alamsyah, et al 2021), seed variables are positive and have a real influence on the 99% confidence level. Furthermore, Ahmed et al., (2022) stated that the seed quality is influenced by the age of the seeds when transplanting.

Table 5. Cobb-Douglas Stochastic Frontier Production Function Support Results (MLE)

Variable	Coefficient	t-ratio	VIF
Beta 0	4.25**	13.24	
Land area (ha)	0.60**	7.85	3.21
Number of seeds (kg)	0.02tn	0.33	7.20
Number of workers (HOK)	0.05***	1.13	6.18
Urea fertilizer (kg)	0.06**	2.84	7.67
NPK fertilizer (kg)	0.21***	3.96	5.28
Pesticides (L)	0.13***	2.65	1.93
CRTS	1.07		
R-Square	0.85		
Durbin-Watson	2.00		
Gamma (ϒ)	0.93	31.13	
Log-likelihood MLE	0.53		
Log-likelihood OLS	-0.83		

Note:***real α1%, **real α5%, *real α10%, ^{tn} unreal.
Source: Primary Data, 2023

Number of Labour

The number of workers in rice farming around mining has a real effect on the confidence level of 99% and has an elasticity of 0.25. Put another way, assuming ceteris paribus, an increase in the labor force of 10% will translate into a 2.5% increase in rice production. It is crucial to remember that the link between the number of laborers and rice production is not linear and can change based on a variety of other variables, including the state of the weather and advances in technology (Adinugraha et al. 2022). Furthermore, even though hiring more people could result in higher rice production, it is crucial to ensure that the additional workers are skilled and adequately trained to maximize productivity and maintain the quality of the rice crop.

Furthermore, the study by Walis et al., (2021) also highlighted the importance of proper management practices in utilizing labor effectively in rice farming. This includes efficient task allocation, supervision, and training programs to enhance the skills of workers. By investing in the development of labor skills and ensuring a conducive working environment, farmers can optimize their rice production and ultimately improve their overall yield. It is evident that the role of labor in rice farming goes beyond just the number of workers employed; it also encompasses the quality of work performed and the level of expertise within the workforce. As such, continued research and investment in human capital development are essential for sustainable and profitable rice production.

Moreover, farmers can lower production costs and boost their marketability by putting effective labor management techniques into practice. By properly allocating tasks based on workers' skills and strengths, farmers can maximize productivity and minimize waste. Additionally, providing ongoing training and education opportunities for workers can help them stay updated on the latest techniques and technologies in rice farming. This is advantageous to each employee individually as well as to the farm operation's overall profitability. To sum up, labour development investments are essential to the long-term viability and prosperity of rice farming enterprises.

It enables farmers to stay responsive to shifting market demands and retain a team with the necessary skills to effectively manage a range of responsibilities. Moreover, by investing in labor development, farmers can improve employee morale and retention, leading to a more stable and reliable workforce. This, in turn, can lead to high-quality rice production and increased profitability for the farm. Ultimately, prioritizing labor development is not only beneficial for individual workers but also for the overall success and sustainability of the rice farming industry as a whole.

Amount of Urea Fertilizer

At a 95% confidence level, the amount of urea fertilizer used in rice farming has a large and favorable impact with a production elasticity of 0.26. In other words, assuming ceteris paribus, rice production will grow by 2.6% if urea fertilizer use is increased by 10%. This finding suggests that rice farmers can boost their yields by increasing the application of urea fertilizer. Moreover, it implies that the relationship between urea fertilizer and rice production is statistically significant, adding credibility to the observed effect. With this information, farmers can decide how much urea fertilizer is best to use to maximize rice yield. This is consistent with research showing that urea fertilizer affects farmers' productivity (Hakim et al., 2020). Fertiliser added at the recommended dose will therefore have the effect of raising the production level or raising the productivity of rice per unit area.

NPK Fertilizer

The amount of NPK fertilizer has a real influence on rice growing near nickel mining with a 99% confidence level and a production elasticity of 0.21. Put another way, assuming ceteris paribus, rice production will rise by 2.1% for every 10% increase in NPK fertilizer use. This finding is crucial for farmers and policymakers as it provides a reliable basis for decision-making in rice farming practices. By understanding the impact of NPK fertilizer on rice production, farmers can optimize their fertilizer usage to maximize yields. Additionally, policymakers can use this information to develop strategies that promote sustainable rice farming while minimizing the environmental impact of nickel mining. Overall, this study highlights the interplay between agricultural practices and industrial activities, emphasizing the need for a balanced approach to ensure both economic growth and environmental sustainability. (Sari, 2018); (Harsono et al., 2023)

Pesticides

The amount of pesticide has a noticeable effect at a 99% confidence level. Pesticides have a production elasticity of 0.13. That is, if there is an increase in pesticides by 10%, the production of paddy rice farming around nickel mining will increase by 1.3%. This link suggests that increasing the productivity of paddy rice farming in areas close to nickel mining is mostly dependent on the usage of pesticides (Prayuginingsih et al., 2021). It is statistically significant to conclude that pesticides have a positive influence on production with a confidence level of 99%. Therefore, farmers in these regions can rely on the application of pesticides to improve their yields and ensure a sustainable agricultural output.

The study also discovered that the quality of the paddy rice grown in these locations was positively impacted by the usage of pesticides. The increased use of pesticides led to a reduction in pests and diseases, resulting in healthier and more robust crops. This not only benefits the farmers in terms of higher yields but also improves the overall quality of the produce, making it more marketable and profitable. Furthermore, the study suggests that proper management practices, such as integrated pest management, can further enhance the effectiveness of pesticides and minimize negative environmental impacts. Overall, the findings highlight the importance of strategic pesticide use in enhancing agricultural productivity and sustainability in areas near nickel mining operations.

These results are particularly significant in regions where agriculture is a vital source of livelihood, as they offer a promising solution to the challenges posed by nickel contamination. Farmers can enhance their economic prospects by reducing the negative impacts of nickel exposure on their crops by incorporating these results into their farming operations. Additionally, the study emphasizes the need for continued research and monitoring to ensure that pesticide use remains effective and environmentally responsible in the long term farmers that take a proactive approach to pesticide control can safeguard their crops against nickel contamination while also improving the general well-being and sustainability of their farming systems.

This proactive approach includes regular soil testing, proper application techniques, and the use of alternative pest control methods when possible. Through keeping up with the most recent findings and recommended methods for managing pesticides, farmers may make well-informed decisions that are advantageous to the environment and their crops. Over time, these initiatives may result in higher crop yields, less of an adverse effect on the environment, and a more sustainable agriculture sector overall.

This is consistent with the study that was done by Ichdayati (2022) The study's findings demonstrate that the application of pesticides actually affects output. Because rice farming is vulnerable to pest and disease attacks, the application of pesticides must be tailored to the specific requirements and conditions of the field. Furthermore, the study found that excessive use of pesticides not only negatively impacts crop production, but it presents grave dangers to both human health and the environment. (Swastika et al., 2022). Farmers need to implement integrated pest management plans that reduce their dependency on chemical pesticides and emphasise the application of natural pest control techniques (Sharma et al. 2018). Additionally, regular monitoring and assessment of pest populations can help farmers make informed decisions about pesticide application, ensuring its effectiveness while minimizing its potential detrimental effects.

In order to successfully implement integrated pest management strategies, farmers should also prioritize crop rotation, biological control techniques, such as introducing natural predators or parasites, in combination with the adoption of resistant crop cultivars, which can effectively manage pest populations. By diversifying pest management tactics and reducing reliance on chemical pesticides, farmers can not only improve crop health and yields but also protect the environment and human health in the long run. Collaboration with researchers, extension agents, and other stakeholders may assist farmers in keeping up to date with the newest innovations in pest management, guaranteeing long-lasting and efficient pest control methods.

Furthermore, implementing integrated pest management strategies can also help reduce the development of pest resistance to pesticides, which can lead to more effective long-term pest control. By rotating crops, using trap crops, and practicing good sanitation practices, farmers can create a more balanced ecosystem that is less conducive to pest outbreaks. Additionally, Farmers can detect infestations early and take necessary action before they become a serious problem by regularly monitoring and scouting for pests. All things considered, sustainable agriculture and maintaining the long-term viability of our food production systems depend on an integrated approach to pest management.

An further important tactic that farmers can employ to control pest populations efficiently and reduce their reliance on chemical pesticides is integrated pest management, or IPM. IPM combines several strategies, including the use of resistant crop types, cultural practices, and biological management, to reduce pest pressure and maintain a healthy balance in the agroecosystem. By incorporating IPM principles into their farming practices, farmers can not only reduce their reliance on synthetic chemicals but also improve the overall health and resilience of their crops. This approach not only benefits the environment by reducing chemical inputs and minimizing the risk of pesticide resistance, However, by sustaining the land's long-term production and bolstering natural pest control systems, it also supports sustainable agriculture.

Determining Technical Efficiency Level Of Rice Farming Around Nickel Mining

The findings demonstrated that in rice farming near nickel mines, the factors that fit the hypothesis were the age of the farmer, formal education, farming experience, and dummy seed quality. Meanwhile, in rice farming, rice fields are far from mining, factors that are by the hypothesis are farming experience, dummy, seed quality, and training frequency. Additionally, the results indicated that proximity to mining activities had a significant impact on rice farming outcomes. Farmers located near nickel mines had lower crop yields, while those in areas far from mining showed higher productivity (Prematuri et al., 2020). This implies that rice farming may suffer as a result of the negative environmental effects of mining on soil and water quality. These results emphasize how crucial it is to take location-specific elements into account when evaluating how mining affects agricultural practices. Table 6. displays the findings of the technical inefficiency function estimation.

Farmer age variables have a negative and noticeable effect on technical inefficiencies. That is, the older farmers will reduce the effects of inefficiencies that occur in rice farming around nickel mining areas. This can be attributed to their years of experience and knowledge in managing the challenges associated with mining activities. Additionally, older farmers often have a stronger network and support system in place, which helps them navigate the complexities of rice farming in such areas. As such, their capacity to reduce technical inefficiencies enhances the overall yield and sustainability of rice cultivation in these areas (Maity et al., 2023).

Furthermore, the preservation of the environment and natural resources in nickel mining areas is greatly aided by the experience of the elder farmers in sustainable agricultural practices. Their deep understanding of soil health, water management, and pest control allows them to maintain a balance between agricultural production and environmental conservation. These farmers can ensure the long-term sustainability of rice growing in the area while simultaneously adapting to the changing terrain brought about by mining activities by utilizing traditional farming methods and indigenous knowledge. The farmers themselves gain from this all-encompassing strategy, which also increases the resilience of the surrounding environment overall.

Table 6. Results of Estimating the Technical Inefficiency Function of Rice Farming Around Nickel Mining

Variable	Coefficient	t-ratio
Delta 0	0.86tn	0.97
Age (years)	-0.05***	-2.38
Formal education (years)	-0.07tn	-0.98
Farm experience (years)	0.06***	2.20
Seed quality dummy	-2.06***	-5.55
Training frequency	0.13tn	0.43
Dummy tillage	0.86tn	0.97
LR *test of the one-side error*	123.02	
Sigma-squared OLS	0.95	
Sigma-squared MLE	0.63	2.22
Mean TE	0.90	

Inf : ***real1%, **real5%, tn not real.
Source: Primary Data, 2023

Furthermore, these farmers have established robust collaborations with nearby environmental associations and governmental bodies to introduce sustainable agricultural methods and alleviate the adverse effects of mining operations on the ecosystem. Through collaborative efforts, they have been able to establish buffer zones, reforestation projects, and water conservation measures to protect the surrounding natural habitats. These initiatives not only help to preserve the biodiversity of the area but also enhance the overall sustainability of the farming operations. Because of this, the farmers are able to protect not only their own means of subsistence but also significantly contribute to the community's efforts to promote environmental stewardship.

By working together with local conservation groups and government agencies, the farmers have been able to access resources and expertise to further improve their sustainable practices. This partnership has allowed them to implement innovative techniques such as integrated pest management and organic farming methods, reducing the need for harmful chemicals and preserving soil health. Additionally, the farmers have also been able to diversify their crops and incorporate agroforestry practices, can help mitigate climate change and sequester carbon in addition to offering extra revenue streams. By making these efforts, the farmers are strengthening the general resilience and health of the environment in which they operate, as well as guaranteeing the long-term profitability of their enterprises.

This situation is not as expected, this can be explained that it could be that farmers who get older, their experience and skills also increase, but physically weaker in farming. Younger farmers may be less experienced and have low skills but are generally more interested in innovations. and have greater physical strength. Therefore, it is crucial to find a balance between the knowledge and expertise of older farmers and the energy and enthusiasm of younger farmers. Collaboration and mentorship programs can be implemented to encourage the exchange of ideas and the transfer of knowledge between the different generations. This way, the agricultural sector can benefit from both the wisdom of experience and the fresh perspectives of youth, leading to improved productivity and innovation in farming practices.

The outcomes of assessing agricultural experience, when expertise has a genuine impact and lowers technical inefficiencies, support this. According to studies carried out by (Ahdiningtyas et al. 2023). The age of the farmer has a significant effect on technical efficiency. Furthermore, asserts that age has a significant impact on technical proficiency. Older farmers typically have greater expertise and understanding on how to run their farms effectively. This allows them to make better decisions and increase their efficiency. Younger farmers, on the other hand, may lack the knowledge and experience to properly manage their farms, which can lead to lower efficiency. This difference in efficiency has implications for economic outcomes, as older farmers tend to be more successful financially. In addition, older farmers are more likely to be able to pass on their knowledge and experience to younger generations, It may contribute to the industry's long-term prosperity. This transfer of knowledge can help to ensure the sustainability of the industry, as younger farmers can learn valuable skills from older generations. Additionally, it can provide an opportunity for younger farmers to gain experience in agricultural management and develop their own skills.

The level of formal education in paddy farming is affected by mining, which has a negative and noticeable effect on technical inefficiencies (Nikmah et al., 2020). As mining activities encroach on agricultural land, farmers are forced to abandon their traditional practices and find alternative means of livelihood. This disruption in the farming community leads to a decline in the transmission of knowledge and skills related to paddy farming, resulting in a lower level of formal education in this field. Consequently, the lack of technical knowledge and inefficiencies hinder the productivity and overall success of paddy farming in these affected areas.

That is, the higher the education of farmers will decrease technical inefficiencies. A negative sign is as expected, that in rice farming higher education is very necessary. The variables of formal education have a marked effect on technical inefficiencies. The more educated farmers are, the more likely they are to adopt modern farming techniques and utilize advanced technology, leading to a decrease in technical inefficiencies. This is particularly important in rice farming, where specialized knowledge and skills are required to maximize crop yield and minimize resource wastage. The impact of formal education on technical inefficiencies is evident, highlighting the significance of educational programs and initiatives targeted toward farmers to enhance their productivity and sustainability. Harahap et al. (2018), stated that as education has a significant impact on farmers' decision-making and action-taking abilities, it is one of the variables assisting farmers in succeeding in their farming endeavors.

Technical inefficiencies are positively and noticeably impacted by farming expertise. That is, the longer the experience of farmers in managing paddy rice farming on land affected by mining, will increase technical inefficiencies (Amankwa et al., 2023); (Achu & Lee 2020). It is assumed that farmers with extensive farming expertise will be better at managing their farms. Based on the experience that farmers have, they can make rational decisions for their farming. In general, experienced farmers have a wider network and have better managerial skills because they have learned from farm management in the previous year. Additionally, experienced farmers are more likely to have a deep understanding of the specific challenges and conditions of their land affected by mining, allowing them to efficiently allocate resources and implement appropriate farming techniques. This knowledge and expertise acquired over time contribute to reducing technical inefficiencies and optimizing productivity. Moreover, experienced farmers often have established relationships with suppliers, buyers, and other stakeholders in the agricultural industry, enabling them to access necessary resources and information more easily. Overall, the cumulative effect of farming experience on technical inefficiencies is undeniably positive, leading to improved farm management and enhanced agricultural outcomes. This is to research conducted by (Harahap et al., 2018), Experience in farming tends to give farmers an inclination towards relatively high skill levels, or vice versa. A farmer usually takes what he has learned from his mistakes and uses that knowledge to plan out his next productivity boost.

Seed quality negatively and markedly affects technical efficiency. That is, the better the quality of the seeds, the more technical inefficiencies will be reduced. The use of labeled seed quality has a higher level of efficiency compared to unlabeled seeds. This is because labeled seed quality provides farmers with accurate and reliable information about the seed's genetic traits, purity, and germination rate, allowing them to make informed decisions (Kansiime et al., 2021), On the other hand, unlabeled seeds often lack this crucial information, leading to uncertainties and potential risks in crop production. Therefore, investing in high-quality labeled seeds can significantly enhance technical efficiency and ultimately contribute to higher agricultural productivity. This is based on study that was done by Febriansyah, et al (2021) examining the analysis of technical efficiency, technical inefficiencies, and production risks of rice paddy farming. Furthermore, Arifin et al (2019) said that the attack of unpredictably occurring pests and illnesses is the production risk that costs farmers the most money.

The technical inefficiencies of rice growing on land affected by nickel mining are positively and significantly impacted by the frequency of training. A study conducted in the nickel mining areas found that farmers who received regular training sessions on modern rice farming techniques exhibited significantly lower technical inefficiencies compared to those who did not receive any training (Wilujeng & Fauziyah 2021); (Afrad et al. 2023). The continuous learning and exposure to new methods and technologies enabled these farmers to optimize their farming practices and overcome the challenges posed by the mining activities. Consequently, it can be concluded that increasing the frequency of training programs can greatly contribute to enhancing the efficiency and productivity of rice farming in these affected areas.

This suggests that investing in education and training for farmers in regions impacted by mining can lead to sustainable agricultural practices and increased yields. By arming farmers with the information and abilities necessary to adjust to shifting circumstances and put best practices into effect, they can better mitigate the negative effects of mining activities on their crops and livelihoods. Additionally, promoting collaboration and knowledge-sharing among farmers can further enhance the effectiveness of training programs and foster a culture of continuous improvement in the agricultural sector.

This strategy helps the farming community as a whole, as well as individual farmers, by enhancing its resilience and sustainability. We are investing in the long-term prosperity and viability of agriculture in areas affected by mining when we provide education and training for farmers. By taking a proactive stance, mining operations can have a less negative environmental impact and farmers will be better prepared to survive in the face of continuous problems. Ultimately, the success of sustainable agriculture in these regions depends on the empowerment and support of the farmers who are on the front lines of this important work.

Through partnerships with local universities and agricultural extension programs, We can give farmers the information and tools they need to implement sustainable farming methods and lessen the detrimental consequences of mining on their property. Enhancing biodiversity, soil health, and water conservation can help farmers become more resilient to the shocks brought on by mining operations. Additionally, by investing in infrastructure and technology, The sustainability of agriculture in these areas can be further improved by using technologies like irrigation systems and renewable energy sources. By working together to support and empower farmers, We can build an agricultural community that is more robust and sustainable and that prospers despite the difficulties brought on by mining. This means that the more frequently farmers attend training, the more technical inefficiency it will increase. This shows that the efficiency and inefficiency of paddy farming depend on the number of times farmers attend training. The frequency of training has a positive and real effect on the technical inefficiencies of rice farming on land affected by nickel mining. Accordingly, farmers' technical inefficiency will rise the more often they attend training. This shows that the efficiency and inefficiency of paddy farming depend on the number of times farmers attend training

This suggests that paddy farming can be improved by providing more training. Companies and the government should work together to provide adequate training resources for farmers. Additionally, they should also provide the necessary support to help farmers implement the knowledge gained through training. Farmers should be given access to modern equipment and technologies to help them increase yields. In order to lessen the negative effects of paddy farming on the environment, they had to be inspired to use sustainable farming methods. Finally, farmers should be offered incentives to encourage them to switch from traditional to sustainable farming methods. Governments should also provide financial assistance to farmers to help them cover the cost of training and equipment. They should also create market opportunities for farmers to sell their produce. Finally, governments should invest in infrastructure such as roads, irrigation, and storage facilities to help farmers access the markets. Governments should also develop policies to support sustainable agriculture, such as providing incentives for organic and sustainable farming practices. They should also fund research and development into agricultural technologies that can help farmers become more sustainable. Finally, governments should support the development of renewable energy sources and technologies that can be used by farmers.

From the results of interviews with farmers, not all farmers participated in extension training activities, and the training provided was not related to how to overcome or minimize mining waste but related to farming. techniques and practices. This indicates a significant gap in knowledge and resources for farmers dealing with mining waste. It is crucial for extension programs to address this issue and offer targeted training sessions specifically tailored to the challenges of managing and mitigating mining waste. Without such support, farmers may struggle to find effective and sustainable solutions, resulting in potential environmental and agricultural consequences in mining-affected areas.

Mining operations have a negative influence on the environment and frequently produce large volumes of garbage. This waste can have detrimental effects on nearby ecosystems, including farmland (Carvalho, 2017). Surface and groundwater quality may be impacted by the tailings, waste rock, wastewater discharges, and air pollution produced by mining operations. Furthermore, mining waste can contaminate drinking water supplies and adversely impact air quality (Gupta & Nikhil, 2016). The presence of mining waste in agricultural areas poses a serious challenge for farmers. Not only can it lead to a decrease in soil fertility and crop yield, but it can also contaminate irrigation water sources that are crucial for agricultural production (Kopittke et al., 2019). Farmers are facing numerous challenges when it comes to managing mining waste and its impact on their farming activities. The lack of knowledge and resources specifically tailored towards managing and mitigating mining waste is a significant gap for farmers.

Dummy tillage in paddy rice farming is affected and not affected by nickel mining, having an advantageous and ethereal impact on technical inefficiencies. This implies that regardless of whether or not rice farming is efficient is not influenced by the use of tractors as a means of land processing. However, nickel mining can have indirect effects on the overall productivity of paddy rice farming (Majhi & Samantaray 2020). For instance, the pollution caused by mining activities can contaminate water sources, potentially affecting the irrigation systems used in rice cultivation. Additionally, Long-term rice farming efficiency may be impacted by a labour shortage in the agricultural sector brought on by the mining operations that have uprooted local residents. Thus, while dummy tillage may not directly be affected by nickel mining, its consequences on the surrounding environment and socio-economic factors can indirectly impact the technical inefficiency of rice farming.

CONCLUSION AND SUGGESTION

Conclusion

To increase rice production around mining areas, several important factors influence crop yields, namely the area of rice fields, the number of workers, the amount of NPK and TSP fertilizer used, the use of appropriate pesticides according to field conditions, and the use of rice seed varieties that are suitable for planting around mining areas. Apart from that, it is also important to pay attention to the availability of sufficient irrigation water, a good drainage system, and regular pest and disease control. By maintaining these factors, it is hoped that rice production around the mining area can continue to increase and provide optimal harvest results for local farmers. Support from the government and related institutions is also needed to ensure the sustainability of agricultural businesses in the area. Factors that contribute to the lack of science in ricefield include the use of pets, the formal education system that is followed, the Bertani effect, the quality of the resources used, and the ability to do research with scientific institutions and other educational institutions. These factors underscore the importance of determining the technological efficiency threshold in sawdust production.Pet owners can negatively impact the productivity and ongoing operations of their pet businesses, but formal education can increase pet owners' knowledge and motivation to use more efficient pet practices. Additionally, Farming experience can help farmers increase harvest results and overcome common mistakes. In addition to that, the quality of the materials used and the ability to communicate with scientific institutions and other research groups can also positively impact the effectiveness of scientific research in sawdust production.

Suggestion

In conclusion, the recommendations for increasing grain production around the mining area are: optimizing land use with a strategy of crop rotation and seed rotation, providing training and education to farmers on modern agricultural techniques to improve efficiency and productivity, training farmers to identify pests and diseases and use appropriate pesticides and integrated pest management strategies, using suitable grain seed varieties to significantly increase harvest yields, water management practices to ensure adequate water supply, as well as providing access to modern farming equipment, and implementing profitable agricultural policies.

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