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Comparative Study Of Environmental Efficiency And Farmer Behavior Facing Production Risks In Ciamis And Kulonprogo Regencies

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Abstract
This study aims to analyze the value of environmental efficiency in inorganic rice production and how to see farmers' attitudes in facing production risks which are influenced by labor, seeds, fertilizers, organic pesticides, chemical fertilizers and chemical pesticides. This research was conducted at two regencies at Minaharjasari Farmers Group, Kertarahayu Village, Pamarican District, Ciamis Regency, West Java Province and Farmers Group in Banjararum Village, Kalibawang District, Kulonprogo Regency, Yogyakarta Special Region Province, Indonesia with a sample of 50 farmers each which was carried out using in-depth interview methods. This research uses a translog stochastic frontier approach and Just and Pope's function model with statistical package for the social sciences method. The results of this research state that from the results of the comparative analysis in Ciamis and Kulonprogo Regencies, the input variable of production which had the most significant influence was the ZA fertilizer variable. Based on the gamma value analysis results table, it can be seen that Ciamis Regency has the lower gamma value compared to Kulonprogo Regency, namely 0.00263 and 0.665. In Ciamis Regency, the average environmental efficiency value was 0.2968, while the average environmental efficiency value in Magelang Regency was 0.2264. This means that the environmental efficiency value in Ciamis and Kulonprogo Regencies has not yet been achieved, even though the environmental efficiency value in Ciamis Regency is still better when compared to Kulonprogo Regency. The attitude of rice farmers in Ciamis Regency in making decisions to increase income by reducing the use of chemical fertilizers is expected, namely that 42% of farmers make decisions that are afraid of risks and 58% of other farmers are brave about risks. In terms of making a decision to choose risk, namely 38% chose low risk and 62% chose moderate risk, while in Kulonprogo Regency there were 52% of farmers who made decisions afraid of risk and 48% of other farmers were brave about risk. In terms of making decisions regarding risk, 54% chose low risk and 46% chose moderate risk.

Keywords: *environmental efficiency, production inputs, production risks, farmers' attitudes*

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I. Introduction

The environmental problems' issues related with water, soil, plants, and animals have become global problems and apprehensive topic since 1970s until now. The Stockholm Declaration emphasized the human responsibility to protect the environment and natural resources including water, soil, plants, and animals both renewable and non-renewable ones for the benefit in the present and the future (Sohn, 1973). Agriculture is one of the areas of human life in which there are living creatures and nature (water, soil, air, etc.) which is essential for human survival in the future.

In the agricultural sector, business and management are important things to pay attention to. Rice farming is a promising business if it is managed well without abandoning sustainable values in economic, social and environmental terms. Good farming should pay attention to sustainability for current and future generations within the framework of sustainable agricultural development (Sudrajat, 2018).

The Indonesian government's policy in increasing rice productivity has caused technological changes in rice farming itself. One of them is the use of more agricultural inputs in order to increase productivity. The doubling of food production has led to an increase in the allocation of nitrogen use to agricultural land. Intensive use of nitrogen will have an impact on environmental damage (Tilman, 1999). Over the past few decades, leaching from agricultural sources has been a significant source of soil and surface water pollution. Therefore, efforts to increase efficiency need to consider environmental consequences. Farmers must be able to apply inputs as efficiently as possible to create an environmentally friendly agricultural sector (Graham, 2004).

Environmentally friendly agriculture is born from a sustainable agricultural system. A sustainable agricultural system is an environmentally friendly agricultural system that aims to improve the quality of human life and the natural surroundings (Salikin, 2003). This sustainable agriculture is in line with Indonesia's development goals. In 2016, Indonesia has entered the era of sustainable development goals or better known as Sustainable Development Goals (SDGs). These SDGs are built through 3 pillars, namely economic, social and environmental pillars which are seen as a complete unit and cannot be separated from one another (Sudrajat et al., 2017; Defidelwina et al., 2019). Sustainable agriculture is often faced with the problem of environmental damage. The use of production inputs in modern agriculture to stimulate production, such as chemical fertilizers and pesticides, has a significant impact on reducing environmental quality in the agricultural sector.

Environmentally friendly agriculture is very important because indirectly in the long term it can be an alternative solution to problems with rice production through natural recycling so as to increase soil productivity. Therefore, the fundamental problem in agriculture besides agricultural efficiency is related to the high risks faced by farmers. According to Barry (1984) the problem of risk and uncertainty in agriculture is not new, because in reality farmers have many decisions related to these risks and uncertainties. So identifying sources of risk is very important in the decision making process. Risk factors in agriculture come from production, prices and markets, business and finance, technology, damage, social and legal as well as humans. Based on these problems, it is very important to carry out an analysis of the risks of rice farming production, especially in the farming management aspect. Farming management factors are expected to be able to improve the level of inefficiency in the use of rice farming production factors and the high risks faced by farmers (Barry, 1984; Sudrajat, 2019b).

This research aims to analyze the comparative value of environmental efficiency of inorganic rice production and how farmers' attitudes face production risks in Ciamis and Kulonprogo Regencies which are influenced by labor, seeds, organic fertilizer, organic pesticides, chemical fertilizers and chemical pesticides. This comparative study uses a translog stochastic frontier approach and Just and Pope's function model with statistical package for the social sciences method with a sample size of 50 farmers in each district conducted using in-depth interview methods.

II. Theoretical Framework

The concept of efficiency and inefficiency in agriculture

Adiyoga (1990) stated that the income level of agricultural businesses (farming) is an important factor to support economic growth and the main determinant of farmer welfare. The level of farming income is largely determined by the efficiency of farmers in allocating their resources to various alternative production activities. Efficient use of resources is an important issue that determines the existence of various opportunities in the agricultural sector related to its contribution to economic growth and increasing the welfare of farmers themselves (Weersink et al., 1990).

Apart from increasing production to improve the quality and quantity of farming, it is necessary to pay attention to the efficiency and inefficiency of farming. Efficiency is a relative concept that is measured by comparing the actual ratio of output to input to the ratio of output to input under optimal conditions. Efficiency is used to measure the economic performance of a company or farm. Measuring efficiency begins with the concept put forward by (Farrel, 1957) which defines efficiency as the ability of a company or farm to produce maximum output using a certain amount of input. Doll & Orazeem (1984); Debertin (1986); Lipsey et al. (1987) defines efficiency as the maximum amount of output achieved by using a certain amount of input or to produce a certain amount of output using the smallest amount of input.

Farrell (1957) stated the reasons for the importance of measuring efficiency, namely: (1) the problem of measuring the production efficiency of an industry is important for economists and economic policy makers; (2) if theoretical reasons for the relative efficiency of various economic systems are to be tested, it is important to be able to make measurements of actual efficiency; (3) if economic planning is closely related to a particular industry it is important to increase output without absorbing additional resources or increasing its efficiency.

Inefficiency is an inseparable part of agricultural life. The issue of inefficiency basically arises from the assumption that farmers and farming behave to maximize profits. In managing their farming business, farmers may make deviations which give rise to certain consequences which can result in the emergence of farming inefficiencies. Failure to achieve maximum output with a given amount of input is called inefficiency. The occurrence of inefficiencies can be caused by limited access to technology, markets, credit, extension, inappropriate production scales, and suboptimal input allocation (Sudrajat, 2020b).

The technical inefficiencies of a farming business need to be considered so that the farmer's ability to run his farming business can be more optimal and there will be no failures in the production process. Byerlee (1987) added to the concept of efficiency failure in farming, technical inefficiency refers to failure to operate the production function caused by the timing and method of application of production inputs. Potential causes of technical inefficiency are imperfect information, low technical capability, and inadequate motivation (Daryanto, 2000).

Stochastic frontier analysis to measure environmental efficiency

Stochastic frontier analysis (SFA) was first introduced by Aigner, Lovell and Schmidt in 1977. SFA is an econometric method used to calculate the level of efficiency of using certain inputs. Farmer production is said to be efficient, if a farmer's production level is higher than the best production level limit (Waryanto et al., 2015). To this function a non-negative random variable (Ui) is added to capture inefficiency factors such as the farmer's education level, farmer's age, and how long he has been a farmer, so that the general form of SFA for one input variable (Safitri, 2014) can be written as follows:

$$Y_i = f(X_i; \beta) \ x \ exp\ \{V_i – U_i\} \quad (1)$$

where Yi is the level of production (output), Xi is the input variable used, β is the parameter to be estimated, Vi is a random variable related to external factors such as climate and pests and its distribution is symmetrical and normally distributed, and Ui is a random variable non-negative which influences the level of inefficiency and is related to internal factors which are assumed to be half-normally distributed.

Reinhard (1999) applies SFA by adding one variable that is considered to be detrimental to the environment with the aim of getting value from environmental efficiency. The general form of the SFA can be written as follows:

$$Y_i = f(X_i; Z_i; \beta) \ x \ exp\ \{V_i – U_i\} \quad (2)$$

Equation (2) is the same as equation (1) except that there is an additional factor Zi, namely an input variable that is considered to be detrimental to the environment. With the translog production function, the complete model (Reinhard, 1999) can be expressed as follows:

$$lnY_i = \beta_0 + \sum_j\beta_j \ ln(X_{ij}) + \beta_z \ ln(Z_i) + 0.5 \sum_j \sum_k \beta_{jk} \ ln(X_{ij}) \ ln(X_{ik}) + \sum_j \beta_{jz} \ ln(X_{ij}) \ ln(Z_i) + 0.5 \ \beta_{zz}(lnZ_i)^2 – u_i + v_i \quad (3)$$

where i = 1, ..., n is the 1st farmer to the nth farmer, j, k = 1,2, ..., p is the input variable used, ln (Y_i) is the logarithm of the output of farmers to i, ln (X_{ij}) is the logarithm of the input variable to j used by the farmers to i, ln (Z_i) is the logarithm of the input variable which is considered to damage the environment by farmers to i, u_i is a non-negative random variable, and affects the level of inefficiency and is related to internal factors and is assumed to be half-normal spread ($u_i \sim |N(u,\sigma_u^2|$), v_i is a random variable related to external factors (climate, pests), the distribution is symmetrical and spread normally ($v_i \sim N(0,\sigma_v 2)$), also β_j, β_z, β_{jk}, β_{jz}, β_{zz} are the parameters to be estimated.

Reinhard (1999); Mkhabela (2011); Guo & Marchand (2012) formulated environmental efficiency in equation 4 below:

$$lnEE_i = [-(\beta_z+\Sigma\beta_{jz}lnX_{ij}+ \beta_{zz}lnZ_i) \pm \{(\beta_z+ \Sigma\beta_{jz}lnX_{ij}+ \beta_{zz}lnZ_i)^2 \ 2\beta_{zz}U_i\}^{0.5}]/\beta_{zz} \quad (4)$$

where lnEEi is the environmental efficiency of the i-th farmer, X_{ij} is the variable of farmer input, Z_i is the detrimental input of the i-th farmer, U_i is the inefficiency factor, and β_z, β_{jz}, β_{zz} are the parameters to be estimated. Reinhard et al. (1999) states environmental efficiency is basically one aspect of technical efficiency because it focuses on one input that has negative consequences on the environment. This measurement is then a non-radial input oriented measurement because only one of the many inputs is examined. The decrease in the level of pollution input will have an impact on both technical efficiency and environmental efficiency.

Farmer's Behavior in Facing Risks

Hardaker et al. (1997) explained that the situation of farmers' decision making in production risk is faced with two things, namely risk and uncertainty. The terms "risk" and "uncertainty" can be defined in various contexts, Risk is uncertain consequences, particularly exposure to unfavorable consequences; and uncertainty as imperfect knowledge. Soekartawi (1993) defines risk as the possibility of loss or the possibility of loss, so the chance of occurrence is known first, whereas uncertainty is something that cannot be predicted beforehand, and because the chance of loss is not known beforehand. Risks in agricultural production are caused by the dependence of agricultural activities on nature, where the adverse effects of nature have greatly influenced the total agricultural yields. Uncertainty situation is intended as a risk of production in farming faced by each farmer and it appears from the variations in production gains and revenues.

Robison & Barry (1987) states risk is the chance of an event that can be measured and based on experience. Uncertainty is the opportunity for an event that cannot be predicted. Risk analysis is related to decision making theory. In this case farmers are assumed to act rationally in decision making. Some sources of risk faced by farmers include: (i) production risk; (ii) market or price risk; (iii) institutional risk; (iv) policy risk; and (v) financial risk. From these sources, it turns out that the most important risks faced by farmers are production risk and product prices. Both of these risks, namely production risk and product price must be considered by farmers to face the problem of risk and uncertainty that will later affect the income received by farmers (Harwood et al., 1999; Moschini & Hennessy, 1999). Ellis (1988) states that the attitudes of farmers in facing production risks are grouped into three, namely: risk aversion, risk neutral, and risk taker.

The attitude of farmers as decision makers in dealing with production risks can be classified into three categories, namely: (1) Decision makers who avoid production risk (risk aversion). This attitude shows that if there is an increase in variance of the profit, the decision maker will compensate by increasing the expected profit which is a measure of the level of satisfaction (utility); (2) Decision makers who dare to face production risk (risk takers). If there is an increase in the range of profits, the decision maker will compensate by increasing the expected profit; (3) Decision makers that are neutral about production risk (risk neutral). If there is an increase in the range of profits, the decision maker will not compensate by increasing or decreasing the expected profit (Robison & Barry, 1987; Sudrajat, 2020a).

Production management and risk management

Osburn & Schneeberger (1978) explain agricultural management is how to plan a farm to be carried out, organize the workforce needed, give direction to the workforce about what needs to be done, coordinate what things are challenges in carrying out these agricultural activities and oversee labor and production so as to achieve the goal, in this case is to get profits or profits for these producers. Production in agribusiness activities can be interpreted as a set of procedures and activities that occur in the creation of agribusiness products (agricultural business products, fisheries, livestock, forestry, and processed products). Agribusiness management is a set of decisions to support the implementation of agribusiness production, from planning, organizing, implementing, controlling, controlling, to evaluating the production process. In this case production management has a comprehensive impact and is related to various functions such as financial, personnel, financial, research and development, procurement and storage functions, and others. Production management involves several things including: location, size or volume decisions, facility layout, purchasing, inventory, scheduling, and production quality (Firdaus, 2008).

Risk management is the systematic application of management policies, procedures and activities for hazard identification, analysis, assessment, handling and monitoring and evaluation of risks. Risk management can also be interpreted as a structured approach in managing uncertainty related to threats. This includes a series of human activities, such as; risk assessment, development of strategies to manage and mitigate risk using empowerment resources owned (Jolly, 1983). Harwood et al. (1999) describes how farmers can manage risk. Risk management carried out by farmers is useful to minimize the level of loss during the production process. Some risk management that can be applied in agricultural activities are business diversification, vertical integration, production contracts, sales contracts, hedging, financial and expenditure management, insurance, liquidity, leasing, insurance and other risk management, such as adding inputs and outputs, using technology, and optimizing the use of machines. The strategies that can be taken in risk management include transferring the risk to other parties, avoiding the risk, reducing the negative effects of the risk, and accommodating some or all of the consequences of a particular risk. Risk management of traditional agricultural production is related to risks that arise in the implementation of production, such as floods, landslides, crop failure due to pests and plant diseases, etc. Related to financial risk management, for example risks that can be managed by using financial instruments, so as to reduce production costs and increase revenue.

III. Materials And Method

Time and place of research

This study was conducted in two regencies, at Minaharjasari Farmers Group, Kertarahayu Village, Pamarican District, Ciamis Regency, West Java Province and Farmers Group in Banjararum Village, Kalibawang District, Kulonprogo Regency, Yogyakarta Special Region Province, Indonesia. Both research locations were chosen because they were used to analyze the comparative value of environmental efficiency and farmer behavior in facing production risks. Both have farmer groups that support farming activities and the location and conditions of farming areas are not much different from the flow of tertiary irrigation water and the contour of the land is relatively flat and suitable for the development of lowland rice farming.

Research sample

In this research, in each district there were 67 inorganic rice farmers who were interviewed in depth. After interviews, 50 samples of farmers were determined who met the requirements. They are members of Minaharjasari Farmers Group, Kertarahayu Village, Pamarican District, Ciamis Regency, West Java Province and Farmers Group in Banjararum Village, Kalibawang District, Kulonprogo Regency, Yogyakarta Special Region Province who have more than 10 years of experience processing rice plants.

Methods used in research

In this research, data exploration and assumption checking were used, namely the assumptions of normality, homogeneity of variance, multicollinearity and autocorrelation (Draper & Smith, 1992). Apart from that, production factor parameters (βj) and intercept ($\beta 0$) were also analyzed as well as production factors that influence rice production results. The estimated results were obtained using the Maximum Likelihood Estimation (MLE) estimation method based on the translog production function model and to determine the farmer behavior on facing production risk on rice production was used Just & Pope's production risk function model, i.e., production function plus the production risk function. Measurement of production risk (Just & Pope, 1979) refers to the method of (Moscardi & de Janvry, 1977). Measurements are made by selecting the most significant factors that influence the determination of regression results with statistical package approach to the social sciences (SPSS) method. The most significant influencing factor parameters are used to determine the level of farmer behavior on facing production risk based on econometric approach.

Data analysis

The environmental efficiency index

Stochastic frontier translog model can be used to estimate the technical efficiency of rice production with the equation:

$$Y_i = F(X_i, \beta) \exp \{V_i - U_i\} \quad (5)$$

Based on the estimated frontier and the level of technical inefficiency, the equation is obtained:

($TE = Y_i/[F(X_i, \beta) \exp \{V_i\} = \exp \{-U_i\}$, used a method developed (Reinhard et al., 2000) to estimate environmental efficiency.

The Cobb-Douglas function does not add any new information to the analysis of environmental efficiency. Therefore, the translog production function is used to estimate environmental efficiency (Reinhard et al., 2002) as below:

$$\ln Y_i = \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + 0{,}5\beta_{11} \ln 2X_1 + 0{,}5\beta_{22} \ln 2X_2 + 0{,}5\beta_{33} \ln 2X_3 + 0{,}5\beta_{44} \ln 2X_4 + 0{,}5\beta_{55} \ln 2X_5 + 0{,}5\beta_{66} \ln 2X_6 + \beta_{12} \ln X_1 \ln X_2 + \beta_{13} \ln X_1 \ln X_3 + \beta_{14} \ln X_1 \ln X_4 + \beta_{15} \ln X_1 \ln X_5 + \beta_{16} \ln X_1 \ln X_6 + \beta_{23} \ln X_2 \ln X_3 + \beta_{24} \ln X_2 \ln X_4 + \beta_{25} \ln X_2 \ln X_5 + \beta_{26} \ln X_2 \ln X_6 + \beta_{34} \ln X_3 \ln X_4 + \beta_{35} \ln X_3 \ln X_5 + \beta_{36} \ln X_3 \ln X_6 + \beta_{45} \ln X_4 \ln X_5 + \beta_{46} \ln X_4 \ln X_6 + \beta_{55} \ln X_5 \ln X_6 + (V_i - U_i) \quad (6)$$

where:

Y_i = the total value of the output for i year of agriculture
X_1 = labor input for i year of agriculture
X_2 = seed input for i year of agriculture
X_3 = organic fertilizer input for i year of agriculture
X_4 = organic pesticides input for i year of agriculture
X_5 = chemical fertilizer input for i year of agriculture
X_6 = chemical pesticides input for i year of agriculture

For each input X_i (i = 1, 2,..., 5) there is an appropriate output elasticity which is explained as a variation of the percentage of the output value for each 1% change in the i year input factors.

In the Cobb-Douglas production function, the estimated parameter is the output elasticity itself, while in this study the production translog function, the output elasticity differs from the estimated parameter and is calculated using a total differential to estimate the translog function. According to Reinhard et al. (2002) its deduction function can be stated as follows:

$$\partial Y/Y = (\partial X_1/X_1)(\beta_1 + \beta_{11} \ln X_1 + \beta_{12} \ln X_2 + \beta_{13} \ln X_3 + \beta_{14} \ln X_4 + \beta_{15} \ln X_5 + \beta_{16} \ln X_6) \quad (7)$$

The environmental efficiency index is the ratio of minimum visibility to the observed inputs that are detrimental to the environment: $EE = \min\{Ø: F(X, ØZ) \geq Y\} \leq 1$ where f (X, ØZ) is a frontier function, X is a vector of inputs, Z is a vector of environmental determinant inputs and Y is the value of the output.

To produce an environmental efficiency index, a new frontier function can be generated by replacing the observed Z input with θZ and $U_i = 0$. To make the development of new functions come from the original or old translog function, if there is only one input that damages the environment, for example X_6 as the only input that damages the environment (Reinhard et al., 2000), so the results can be written as follows:

$$0{,}5\beta_{66}(\ln ØZ - \text{Ln}Z)^2 + [\beta_6 + \beta_{16} \ln X_1 + \beta_{26} \ln X_2 + \beta_{36} \ln X_3 + \beta_{46} \ln X_4 + \beta_{56} \ln X_5 + \beta_{66} \ln Z](\ln ØZ - \ln Z) + U_i = 0 \quad (8)$$

Because lnEE = lnØ = ln (ØZ-lnZ, the above function can be written in equation 8 as follows:

$$0{,}5\beta_{66}(\ln EE)^2 + [\beta_6 + \beta_{16} \ln X_1 + \beta_{26} \ln X_2 + \beta_{36} \ln X_3 + \beta_{46} \ln X_4 + \beta_{56} \ln X_5 + \beta_{66} \ln Z] \ln EE + U_i = 0 \quad (9)$$

This equation can be solved as follows:

$$\ln EE = \{-(\beta_6 + \beta_{16} \ln X_1 + \beta_{26} \ln X_2 + \beta_{36} \ln X_3 + \beta_{46} \ln X_4 + \beta_{56} \ln X_5 + \beta_{66} \ln X_6 + (\beta_6 + \beta_{16} \ln X_1 + \beta_{26} \ln X_2 + \beta_{36} \ln X_3 + \beta_{46} \ln X_4 + \beta_{56} \ln X_5 + \beta_{66} \ln X_6 [\beta_{66} \ln X_6]^2 - 2\, \beta 6_6 U_i]^{0,5}\}/\beta_{66} = 0 \quad (10)$$

If there are 2 inputs that damage the environment, for example X5 and X6 as two inputs that damage the environment, the results can be written as follows (Reinhard et al., 2002):

$$(0{,}5\beta_{66} + 0{,}5\beta_{55} + \beta_{56}) \ln 2EE + [\beta_5 + \beta_{15} \ln X_1 + \beta_{25} \ln X_2 + \beta_{35} \ln X_3 + \beta_{45} \ln X_4 + \beta_{55} \ln X_5 + \beta_{56} \ln X_6 +$$

$\beta_5+\beta_{15}\ln X_1+\beta_{25}\ln X_2+\beta_{35}\ln X_3+\beta_{45}\ln X_4+\beta_{55}\ln X_5+\beta_{56}\ln X_6+\beta_6+\beta_{16}\ln X_1+\beta_{26}\ln X_2+\beta_{36}\ln X_3+\beta_{46}\ln X_4+\beta_{56}\ln X_5+\beta_{66}\ln X_6)\ln EE + U_i = 0$ (11)

This can be solved as follows:

$\ln EE=\{-(\beta_5+\beta_{15}\ln X_1+\beta_{25}\ln X_2+\beta_{35}\ln X_3+\beta_{45}\ln X_4+\beta_{55}\ln X_5+\beta_{66}\ln X_6+\beta_6+\beta_{16}\ln X_1+\beta_{26}\ln X_2+\beta_{36}\ln X_3+\beta_{46}\ln X_4+\beta_{56}\ln X_5+\beta_{66}\ln X_6)^2-4(0{,}5\beta_{66}+ 0{,}5\beta_{56}+0{,}5\beta_{55})U_i]^{0,5}\}/(\beta_{66}+\beta_{55}+2\beta_{45})$ (12)

In this function, "+√" is included in the model because if Ui=0, only when "+√" is used, lnEE is equal to "0". Therefore, in this model, the environmental efficiency index can be calculated using: EE = exp (lnEE) = Ø = (ØZ)/Z, where Ø is the environmental efficiency index. In this case, software 4.1 can be used to estimate the stochastic frontier function (Coelli, 1996).

Farmer behavior on facing production risk

To determine the farmer behavior on facing production risk on inorganic rice farming system in Ciamis and Kulonprogo Regencies was used Just & Pope's production risk function model, i.e., production function plus the production risk function. Measurement of production risk (Just & Pope 1979) refers to the method of (Moscardi & de Janvry 1977). Measurements are made by selecting the most significant factors that influence the determination of regression results. The most significant influencing factor parameters are used to determine the level of farmer behavior on facing production risk based on econometric approach. The production risk function can be formulated as follows:

$y = f_j(x, z) + u = f_j(x, z) + h_j(x, z)\, \varepsilon$

where:

y = the number of output
x = vector of the number of variables input (x_i,..., x_j)
z = vector of the number of quasi fixed input (z_i, ..., z_k)
$f_j(x,z)$ = production function
$h_j(x, z)\,\varepsilon$ = production risk function
u = heteroskedastic error term with mean = nol and varians = $(h\,(.))^2$
ε = homoskedastic error term with mean = nol and varians = 1

If $h_j(x,z)$ is positive, it means the addition of input j can raise the risk, on the contrary, if $h_j(x,z)$ is negative, it means the addition of input j can reduce the risk. The description of the translation of the formula is:

$f_j(x,z)$ = production function
Y = rice production (kg/ha/planting season)
X_1 = labor input for i year of agriculture (ha/planting season)
X_2 = seed input for i year of agriculture (kg/ha/planting season)
X_3 = organic fertilizer input for i year of agriculture (kg/ha/planting season)
X_4 = organic pesticides input for i year of agriculture (liter/ha/planting season)
X_5 = chemical fertilizer input for i year of agriculture (liter/ha/planting season)
X_6 = chemical pesticides input for i year of agriculture (kg/ha/planting season)

To calculate the farmer behavior on production risk is used a function of behavior on risk as follows:

$f_j = \tilde{w}_j - h_j\theta_i$ where:

$$\theta_i \equiv \frac{E\left[U'\left(\frac{\pi^e}{p}\right)\varepsilon\right]}{E\left[U'\left(\frac{\pi^e}{p}\right)\right]}$$

where:

f_j = marginal product with input j
w_j = normalized input price j
h_j = first derivative of risk function to input j
θ_i = production risk behavior

Hypotheses

Testing hypotheses about farmer behavior in dealing with risks and on choosing the level of production risk on inorganic rice farming in Ciamis and Kulonprogo Regencies is carried out in the form of the following hypothesis:

If $h_j > 0$ and $\theta_i < 0$ => $f_j < \tilde{w}_j - h_j\theta_i$ => f_j should increase, so that $f_j = \tilde{w}_j - h_j\theta_i$, or x_j input should decrease. Therefore, if $h_j > 0$ and $\theta_i < 0$, it means the farmers are afraid facing the risk (risk averse). On the other hand, if $h_j > 0$ and $\theta_i > 0$ so the farmers are dare facing the risk (risk seeking).

If $h_j < 0$ and $\theta_i > 0$ => $f_j < \tilde{w}_j - h_j\theta_i$ => f_j should increase, so that $f_j = \tilde{w}_j - h_j\theta_i$, or x_j input should increase. Therefore, if $h_j < 0$ and $\theta_i > 0$ so the farmers are afraid facing the risk (risk averse). On the other hand, if $h_j < 0$ and $\theta_i < 0$ so the farmers are dare facing the risk (risk seeking).

IV. Results And Discussion

The most significant variable influence in Ciamis and Kulonprogo regencies

In this study rice production at Minaharjasari Farmers Group, Kertarahayu Village, Pamarican District, Ciamis Regency was influenced by several production input variables, namely: labor, seeds, urea fertilizer, phonska fertilizer, and ZA fertilizer. These variables are used to see the extent of its influence in inorganic rice production and furthermore what effect it has on the environment, especially on environmental efficiency. The description of the results of research in Ciamis Regency shows that the variable of labor has a negative effect on production at a significance level of 99%. The variables that have a positive effect on production at the significance level of 5% and 1% are the variable phonska fertilizer and ZA fertilizer. This means, if both fertilizers increase by 1%, then rice production will also increase by 0.0805 and 2.3555. In this study, the input variable of production which had the most significant effect was the ZA fertilizer variable. The results of the study in Ciamis Regency can be seen in Table 1.

Tabel 1. Estimation result of factors causing environmental inefficiency in Ciamis Regency

Variable	Parameter	Coefficient	Standard Error	Z	P>|Z|
Labor	X_1	-1.843039	0.522072	-3.53	0.000
Seed	X_2	0.0781755	0.157934	0.49	0.621
Urea fertilizer	X_3	0.0268928	0.0189927	1.42	0.157
Phonska fertilizer	X_4	0.080539	0.0343519	2.34	0.019
ZA fertilizer	X_5	2.355543	0.5351164	4.4	0.000
Constant		31.52238	5.853041	5.39	0.000
$\ln Sigma^2 v$		-1.211934	0.214965	-5.64	0.000
$\ln Sigma^2 u$		-7.129913	80.25636	-0.09	0.929
Sigma v		0.5455446	0.0586367		
Sigma u		0.0282982	1.135556		
Sigma-square		0.2984219	0.0723069		
Lambda		0.0518713	1.158202		
Sigma u		0.028			
Sigma v		0.545			
Gamma		0.00263			
Number of objects		50			

(Source: Primary data analysis, 2024)

From the table of environmental efficiency value analysis results, it can be seen that the labor variable has a negative effect on production. The variables Phonska fertilizer and ZA fertilizer have a positive effect on production. The seed and urea fertilizer variables were not significant. Kulonprogo Regency has a gamma or inefficiency value of 0.665. This shows that Kulonprogo Regency is experiencing environmental degradation. In other words, the contribution of inputs, namely phonska fertilizer and manure, to environmental pollution is quite influential. The higher the inefficiency value, the greater the contribution of chemical fertilizer and pesticide inputs to environmental degradation. In this study, the input variable of production which had the most significant effect was the ZA fertilizer variable. The results of the estimation of factors causing production efficiency in Kulonprogo Regency can be seen in Table 2.

Table 2. Estimation results of factors causing production efficiency in Kulonprogo Regency

Variable	Parameter	Coefficient	Standard Error	Z	P>|Z|
Labor	X_1	-0.5612407	0.281735	-1.99	0.046
Seed	X_2	0.0343931	0.1695717	0.20	0.839
Urea Fertilizer	X_3	-0.0545695	0.0325659	-1.68	0.094
Phonska Fertilizer	X_4	0.0102269	0.0122317	0.84	0.403

ZA Fertilizer	X_5	1.128659	0.2143454	5.27	0.000
Constant		19.21986	2.475445	7.76	0.000
$\ln Sigma^2 v$		-1.971032	0.564435	-3.49	0.000
$\ln Sigma^2 u$		-1.285361	0.8535339	-1.51	0.132
Sigma v		0.3732466	0.1053367		
Sigma u		0.525881	0.2244286		
Sigma-squared		0.4158639	0.1773109		
Lambda		1.408937	0.3166416		
Gamma		0.665			
Number of objects		50			

(Source: Primary Data Analysis, 2024)

Based on the gamma value analysis results table, it can be seen that Ciamis Riegency has the lower gamma or inefficiency value compared to Kulonprogo Regency, namely 0.00263 and 0.665. This shows that Ciamis Regency has smaller experienced environmental degradation than Kulonprogo, or in other words the contribution of inputs in Ciamis Regency namely chemical fertilizers and pesticides to the smaller environmental pollution than Kulonprogo. This means that the higher the inefficiency value, the greater the contribution of chemical fertilizer and pesticide inputs to environmental degradation. Reality in the field in Ciamis Regency shows a picture that supports the gamma value analysis. Ciamis Regency farmers have not used chemical fertilizers and pesticides for a long time, so the impact on environmental efficiency is low. And vice versa for a description of Kulonprogo Regency shows a gamma value of 0.665, which means the contribution of chemical inputs and chemical pesticides is greater than Ciamis Regency. The amount of inefficiency has an impact on environmental degradation. The supporting factor for environmental degradation is influenced by the high number of farmers in the use of chemical fertilizers and pesticides, especially in Kulonprogo Regency.

Value of elasticity of production factors in Ciamis and Kulonprogo Regencies

The results of the stochastic frontier translog regression analysis show that there are two independent variables that influence inorganic rice production in Ciamis and Kulonprogo Regencies. The variables that have a big influence are the interaction of labor and seeds, labor and urea fertilizer and seeds and urea fertilizer. The magnitude of the influence between the two production factors can be seen from the elasticity value of each production factor. Elasticity states the rate of change in production factors regarding production. The estimated parameter coefficient β in the translog production function is not an input elasticity value. The elasticity values in the translog frontier stochastic production function can be seen in Table 3.

Table 3. Value of elasticity of production factors

Production Factors	Elasticity Value in Ciamis Regency	Elasticity Value in Kulonprogo Regency
Labor	-0.0038	-0.0067
Seed	0.1068	0.1437
Urea fertilizer	-0.0073	-0.0055
Phonska Fertilizer	-0.4231	-0.4076
ZA Fertilizer	-0.3549	-0.3564

(Source: Primary Data Analysis, 2024)

From Table 3 it can be seen that Ciamis Regency has the highest seed elasticity value compared to other variables, namely 0.1068. This means that every 10% increase in seed use will increase production by 1,068%. Apart from seeds, the elasticity values for labor and urea fertilizer are quite large when compared with the variables for Phonska fertilizer and ZA fertilizer, namely -0.0038 and -0.0073. In Kulonprogo Regency, it can be seen that the seed elasticity value is also the highest compared to other variables, namely 0.1437. This means that every 10% increase in seed use will increase production by 1,437%. Apart from seeds, the elasticity values for labor and urea fertilizer are quite large when compared with the variables for Phonska fertilizer and ZA fertilizer, namely -0.0067 and -0.0055. From the data from the two districts, it can be seen that the decline in production due to labor and urea fertilizer is not too large, but if this continues, rice production will continue to decline, even having a negative impact on the agricultural environment, and it will no longer be efficient.

Value of farmers' environmental efficiency in Ciamis and Kulonprogo Regencies

Environmental efficiency calculations are carried out using the estimated β value that has been obtained from the stochastic frontier translog production function equation. The beta values used are only those that interact with Z or nitrogen surplus. The beta values are βz, βzz, β1z, β2z, β3z, β4z, and β5z.

Based on the analysis results (Table 4), inorganic rice farmers in Ciamis Regency obtained an average environmental efficiency (EEnv) value of 0.2968, with the lowest value being 0.07 and the highest value being 0.489. In Kulonprogo Regency the average environmental efficiency (EEnv) value is 0.2264 with the lowest value being 0.05 and the highest value being 0.435. In general, the environmental efficiency values in Ciamis and Kulonprogo Regencies do not appear to be efficient from the existing environmental aspects. It could be that the use of chemical fertilizers or pesticides in rice farming does not comply with the recommended dosage. Here it can be seen that Ciamis Regency is still slightly more efficient compared to Kulonprogo Regency.

Table 4. Value of farmers' environmental efficiency

Environmental Efficiency	Ciamis Regency		Kulonprogo Regency	
	Number of Farmers	Percentage (%)	Number of Farmers	Percentage (%)
0.0 ≤ EEnv < 0.1	3	6	2	4
0.1 ≤ EEnv < 0.2	8	16	23	46
0.2 ≤ EEnv < 0.3	13	26	16	32
0.3 ≤ EEnv < 0.4	19	38	4	8
0.4 ≤ EEnv < 0.5	7	14	5	10
Amount	50	100	50	100

(Source: Primary Data Analysis, 2024)

The most significant factors influence on production risk

The production of organic rice is determined by the use of its inputs, such as the labor, the number of rice seeds, the amount of urea fertilizer, the amount of Phonska fertilizer, the amount of ZA fertilizer. Risk is caused by the production function by selecting the most significant factors that will influence the determination of the regression results. The most significant influencing factor parameters are used to determine the level of farmer behavior in facing production risk based on econometric approach. Table 5 and 6 shows the parameters of the most significant factors that influence the determination of regression results in Ciamis and Kulonprogo Regencies. These parameters will be used to determine the level of farmer behavior in facing production risk based on econometric approach.

Table 5. Most significant coefficient of production risk factors in Ciamis

Model	Unstandardized Coefficients		Standardized Coefficients	t-count	Significant
	β	Standard Error	β		
(Constant)	5.844	1.014		5.704	0 .000
X_2	0.195	0.074	0.379	2.614	0.009
(Constant)	4.791	1.067		4.429	0.000
X_2	0.342	0.090	0.425	3.759	0.007
X_5	-0.264	0.095	-0.227	-2.745	0.006

(Source: Primary Data Analysis, 2024)

The most significant factor influencing and contributing greatly to the risk of rice production in Ciamis Regency is the number of rice seeds with coefficient of 0.425 (Table 5) and in Kulonprogo Regency is 0.384 (Table 6). In order to match production function {f (x, z)} and production risk function {h (x, z) ε} it is necessary to look at the factor of production which has the greatest contribution to organic rice production, i.e. the number of rice seed factor (X_2). Furthermore, it should be seen that f_j (marginal product with input j), w_j (normalized input price j), h_j (first derivative of risk function to input j) and θ_i (production risk behavior) from calculation result using SPSS (Statistical Package for the Social Sciences) method (Pallant 2010). As the most dominant factor, the number of rice seeds is very influential on rice production and production risk. If the number of rice seeds is higher, the rice production will be greater; and if the number of rice seeds the number of rice seeds is higher, then the behavior of farmers in making decisions facing production risk in terms of risk seeking will be even greater.

Table 6. Most significant coefficient of production risk factors in Kulonprogo

Model	Unstandardized Coefficients		Standardized Coefficients	t-count	Significant
	β	Standard Error	β		
(Constant)	5.826	1.213		5.264	0.007
X_2	0.182	0.064	0.177	2.534	0.009
(Constant)	4.778	1.063		4.089	0.000
X_2	0.317	0.078	0.384	3.759	0.000
X_5	-0.242	0.087	-0.219	-2.785	0.005

(Source: Primary Data Analysis, 2024)

Farmer behavior toward organic rice production risk

Farmer behavior towards rice production risk is assumed to maximize the expected utility from normalized profit with price. The attitude of rice farmers in Ciamis and Kulonprogo Regencies on making decisions can be shown in Table 7 below.

Table 7. Farmer behavior on production risk in Ciamis and Kulonprogo Regencies

Risk Averse Arrow-Pratt	Ciamis Regency		Kulonprogo Regency	
	Number of samples	Percentage	Number of samples	Percentage
Risk Averse (RA)	21	42	26	52
Risk Seeking (RS)	29	58	24	48
Total	50	100	50	100

(Source: Primary Data Analysis, 2024)

From Table 7 in Ciamis Regency can be seen that from the 50 samples, there are 42% of the farmers (21 people) making decisions are afraid of risk (risk averse). Anorganic rice farmer behavior shows that if there is an increase of variance in profit then the farmers will compensate by raising the expected profit and it is a measure of satisfaction level of the farmers. While 58% of other farmers (29 people) are dare to take risk (risk seeking). In Kulonprogo Regency can be seen that from the 50 samples, there are 52% of the farmers (26 people) making decisions are afraid of risk (risk averse). Anorganic rice farmer behavior shows that if there is an increase of variance in profit then the farmers will compensate by raising the expected profit and it is a measure of satisfaction level of the farmers. While 48% of other farmers (24 people) are dare to take risk (risk seeking). The farmer's behavior shows that if there is an increase in profit range, the farmers will compensate by lowering the expected profit. Furthermore, to see the level of risk faced by farmers, the coefficient of variation was used. The greater value of coefficient of variation shows the greater risk of anorganic rice production and conversely, the smaller value of coefficient of variation shows the smaller risk of production risk of inorganic rice farming.

Tabel 8. Farmer behavior in facing risk is based on the coefficient of variation value

Risk Level	Value criteria K(s)	Ciamis Regency		Kulonprogo Regency	
		Number of samples	Percentage (%)	Number of samples	Percentage (%)
Low Risk	$0,0 < K(s) < 0,4$	19	38	27	54
Intermediate Risk	$0,4 \leq K(s) < 1,2$	31	62	23	46
High Risk	$1,2 \leq K(s) < 2,0$				
Amount		50	100	50	100

(Source: Primary Data Analysis, 2024)

Farmers' choice of risk (risk preference) describes additional risk followed by additional utility. Table 8 shows that the behavior of rice farmers in Ciamis Regency is 38% making the decision to choose low risk and the remainder (62%) choosing moderate risk (intermediate risk) and there are no farmers choosing high risk, whereas in Kulonprogo Regency 54% of farmers made the decision to choose low risk and the remainder (46%) chose moderate risk (intermediate risk) and there were no farmers choosing high risk. Regarding risks, rice farmers should be provided with price information, both by the government and related agencies. No less important is the need to strengthen farmers' bargaining position through institutional strengthening and farming management. This is intended so that business ventures in the agricultural sector can develop further in the future.

V. Conclussion

From the results of the comparative analysis in Ciamis and Kulonprogo Regencies, it can be seen that the input variable of production which had the most significant influence was the ZA fertilizer variable for Ciamis and Kulonprogo Regencies. Based on the gamma value analysis results table, it can be seen that Ciamis Regency has the lower gamma or inefficiency value compared to Kulonprogo Regency, namely 0.00263 and 0.665.

In Ciamis Regency, it can be seen that the seed elasticity value is the highest, namely 0.1068, likewise in Kulonprogo Regency, the highest seed elasticity value is compared to other variables, namely 0.1437. This means that every 10% increase in seed use in Ciamis Regency will increase production by 1.068%, likewise in Kulonprogo Regency it will increase production by 1.437%.

Based on the results of the analysis of inorganic rice farmers in Ciamis Regency, the average environmental efficiency (EEnv) value was 0.2968, while the average environmental efficiency (EEnv) value in Magelang Regency was 0.2264. This means that the environmental efficiency value in Ciamis and Kulonprogo Regencies has not yet been achieved, even though the environmental efficiency value in Ciamis Regency is still better when compared to Kulonprogo Regency.

The attitude of rice farmers in Ciamis Regency in making decisions to increase income by reducing the use of chemical fertilizers is expected, namely that 42% of farmers make decisions that are afraid of risks (risk averse) and 58% of other farmers are brave about risks (risk seeking). In terms of making the decision to choose risk, namely 38% chose low risk and 62% chose moderate risk (intermediate risk), whereas in Kulonprogo Regency there were 52% of farmers who made decisions afraid of risk (risk averse) and 48% Other farmers dare to take risks (risk seeking). In terms of making decisions regarding risk, 54% chose low risk and 46% chose moderate risk.

References

[1] Adiyoga, W. 1990. Several Alternative Approaches To Measure Efficiency Or Inefficiency In Farming. Informatika Pertanian, 8(1): 487-497.

[2] Barry, P.J. 1984. Risk Management In Agriculture. Iowa State University Press, Iowa.

[3] Byerlee, D. 1987. Maintaining The Momentum In Post-Green Revolution Agriculture: A Micro-Level Perspective From Asia. Msu International Development Paper No. 10. University Of Michigan, Michigan.

[4] Coelli, T.J. 1996. A Guide To Frontier Version 4.1.: A Computer Program For Stochastic Frontier Production And Cost Function Estimation. Center For Efficiency And Productivity Analysis, New South Wales University Of New England Armidale.

[5] Daryanto, H.K. 2000. Analysis Of The Technical Efficiency Of Rice Production In West Java Province, Indonesia: A Stochastic Frontier Production Function Approach. A Thesis Submitted For Degree Of Doctor Of Philosophy. School Of Economics, University Of New England Armidale, Nsw, Australia.

[6] Debertin, D.L. 1986. Agricultural Production Economics. Second Edition. Mc. Graw Hill Inc., New York.

[7] Defidelwina, Jamhari, Waluyati, L.R., & Widodo, S. 2019. The Impact Of Lowland Rice Ownership On Technical And Environmental In Rokan Hulu Regency. Agraris: Journal Of Agribusines And Rural Development Research, 5(1): 79-87.

[8] Doll, J.P. & Orazeem, F. 1984. Production Economics: Theory With Applications. John Wiley & Sons, New York.

[9] Draper, N. & Smith, H. 1992. Applied Regression Analysis. Sumantri B, (Translator). Penerbit Pt Gramedia Pustaka Utama, Jakarta.

[10] Ellis, F. 1988. Peasant Economics: Farm Household And Agricultural Development. Cambridge University Press, Cambridge.

[11] Farrell, M.J. 1957. The Measurement Of Productive Efficiency. Journal Of The Royal Statistics Society, 120(3): 253-290.

[12] Firdaus, M. 2008. Agribusiness Management. Bumi Aksara, Jakarta.

[13] Graham, M. 2004. Environmental Efficiency: Meaning And Measurement And Application To Australian Dairy Farms. Presented At The 48th Annual Aares Conference, Melbourne, Victoria, Australia.

[14] Guo, H. & Marchand, S. 2012. The Environmental Efficiency Of Organic Farming In Developing Countries: A Case Study From China. Etudes Et Documents, 1(1): 1-34.

[15] Hardaker, J. B., Huirne, R. B. M., & Anderson, J. R. 1997. Coping With Risk In Agriculture. Cab International, New York.

[16] Harwood, J., Heifner, R., Coble, K., Perry, J., & Somwaru, A. 1999. Managing Risk In Farming: Concepts, Research, And Analysis. Market And Trade Economics Division And Resource Economics Division, Economic Research Service, Department Of Agriculture Of Usa. Agricultural Economic Report No. Aer-774, 130 Pp.

[17] Jolly, R. W. 1983. Risk Management In Agricultural Production. American Journal Of Agricultural Economics, 76(1): 1107-1113.

[18] Just, R. E. & Pope, R. D. 1979. Production Function Estimation And Related Risk Consideration. American Journal Of Agricultural Economic, 6(2): 276-284.

[19] Lipsey, R.G., Steiner, P.O., & Purvis, D.D. 1987. Economics. Harper And Row Publishers, New York.

[20] Mkhabela, T.S. 2011. An Econometric Analysis Of The Economic And Environmental Efficiency Of Dairy Farms In The Kwazulu-Natal Midlands. Unpublished Doctoral Dissertation, Stellenbosch University, South Africa.

[21] Moscardi, E. & De Janvry, A. 1977. Attitudes Towards Risk Among Peasants: An Econometric Approach. American Journal Of Agricultural Economic, 59(4): 710-716.

[22] Moschini, G. C. & Hennessy, D. 1999. Uncertainty, Risk Aversion And Risk Management For Agricultural Producers. The Agribusiness Commons, Agricultural Economics Commons, And The Business Administration, Management And Operations Commons. Economic Staff Paper Series. Iowa State University Press, Usa.

[23] Osburn, D., & Schneeberger, K. C. 1978. Modern Agricultural Management. Reston Publishing Company, Inc., Virginia.

[24] Pallant, J. 2010. A Step By Step Guide To Data Analysis Using The Spss Program, Spss Survival Manual. Allen And Unwin Books, Australia.

[25] Reinhard, S. 1999. Econometric Analysis Of Economic And Environmental Efficiency Of Dutch Dairy Farms. Unpublished Doctoral Dissertation, Wageningen Agricultural University, Dutch.

[26] Reinhard, S., Lovell, C.A.K., & Thijssen, G. 1999. Econometric Estimation Of Technical And Environmental Efficiency: An Application To Dutch Dairy Farms. American Journal Of Agricultural Economics, 81(1): 44-60.

[27] Reinhard, S., Lovell, C. A. K., & Thijssen, G. 2000. Environmental Efficiency With Multiple Environmentally Detrimental Variables: Estimated With Sfa And Dea. European Journal Of Operational Research, 121(1): 287-303.

[28] Reinhard, S., Lovell, C. A. K. & Thijssen, G. 2002. Analysis Of Environmental Efficiency Variation. American Journal Of Agricultural Economics, 84(4): 1054-1065.

[29] Robison, L. & Barry, P.J. 1987. The Competitive Firm's Response To Risk. Macmillan Publishing Co., New York.

[30] Safitri, A.S. 2014. Analysis Of The Environmental Efficiency Of Sustainable Shallot Farming In Nganjuk Regency, East Java Using The Stochastic Frontier Analysis (Sfa) Method. Unpublished Master's Thesis. Institut Pertanian Bogor, Indonesia.

[31] Salikin, K.A. 2003. Sustainable Agricultural Systems. Kanisius, Yogyakarta.

[32] Soekartawi 1993. Risks And Uncertainties In Agribusiness: Theory And Application. Raja Grafindo Persada, Jakarta.

[33] Sohn, L.B. 1973. The Stockholm Declaration On The Human Environment. The Harvard International Law Journal, 14(1): 423-515.

[34] Sudrajat, I.S., Rahayu, E.S., Kusnandar, & Supriyadi 2017. Effect Of Social Factors In Stochastic Frontier Profit Of Organic Rice Farming In Boyolali. Bulgarian Journal Of Agricultural Science, 23(4): 551-559.

[35] Sudrajat, I.S. 2018. Socio-Economic Factors In The Efficiency Of Organic Rice Farming In Boyolali Regency, Central Java. Unpublished Doctoral Dissertation. University Of Sebelas Maret Surakarta, Indonesia.

[36] Sudrajat, I.S. 2019. Farmer Behavior On Facing Production Risk Of Organic Rice Farming In Indonesia. Journal Of Economics And Sustainable Development, 10(8): 1-8.

[37] Sudrajat, I.S. 2020a. Correlation Of The Influence Of Management Factor And Farmer's Behavior In Technical Efficiency And Production Risk: A Case Study On Organic Rice Farming With Environmental Perspectives In Indonesia. International Journal Of Economics, Business And Management Studies, 7(1): 27-44.

[38] Sudrajat, I.S. 2020b. Efficiency Of Organic Rice Farming. Uns Press, Surakarta.

[39] Tilman, D. 1999. Global Environmental Impacts Of Agricultural Expansion: The Need For Sustainable And Efficient Practices. Proceedings Of The National Academy Of Sciences, 96(11): 5995-6000.

[40] Waryanto, B., Indahwati, & Safitri, A.S. 2015. Analysis Of Environmental Efficiency With One Detrimental Input Variable Using A Stochastic Frontier Analysis Approach: Case Study Of Shallot Farming. Informatika Pertanian, 24(2): 233-244.

[41] Weersink, A., Turvey, C.G., & Godah, A. 1990. Decomposition Measures Of Technical Efficiency For Ontario Dairy Farms. Canadian Journal Of Agricultural Economics, 38(1): 439-456.