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APPLICATION OF INPUT MANAGEMENT AND INTEGRATED PEST MANAGEMENT ON PADDY PRODUCTION: CASE STUDY IN KAMPAR SUBDISTRICT, KAMPAR DISTRICT, RIAU PROVINCE

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Abstract: The attack levels of plant pest organisms (PPO) highly influence the productivity of paddy rice farming. With the increasing human awareness of the dangers of using pesticides, especially for the environment and human health, PPO control prioritizes preventive control by applying the principles of integrative pest management (IPM), which prioritizes the application of healthy crop cultivation, routine observation, utilization of natural enemies and farmers as IPM experts. The use of inputs by farmers in production activities can affect the resulting production. This study aimed to estimate the effect of input management, IPM, and non-IPM on paddy rice production. The analysis used in this study was the Cobb-Douglas production function with the multiple linear regression method. Partially, each variable of land area, seeds, inorganic fertilizers, and dummy variables of IPM or non-IPM farmers significantly affected paddy rice production in Kampar Subdistrict. Variables of organic fertilizers, natural pesticides interacted with frequency, chemical pesticides interacted with frequency, and labor partially had no significant effect on lowland paddy rice production in Kampar Subdistrict. It is necessary to re-enact counseling on IPM in Kampar Subdistrict, Kampar District, to apply IPM principles that prioritize preventive PPO control to avoid the dangers of using pesticides for the environment and human welfare.

Keywords: Cobb-Douglas, plant pest organisms, integrative pest management, non-IPM, rice paddy production

Abstrak: *Tingkat serangan organisme pengganggu tanaman (OPT) sangat memengaruhi produktivitas usaha tani padi sawah. Dengan semakin berkembangnya kesadaran manusia terhadap bahaya penggunaan pestisida, terutama bagi lingkungan hidup dan kesehatan manusia, maka pengendalian OPT mengedepankan pengendalian secara preventif dengan menerapkan prinsip-prinsip pengendalian hama terpadu (PHT) yang mengutamakan penerapan budidaya tanaman sehat, pengamatan rutin, pemanfaatan musuh alami dan petani sebagai ahli PHT. Penggunaan input oleh petani dalam kegiatan produksi dapat berpengaruh terhadap produksi yang dihasilkan. Tujuan penelitian ini adalah untuk mengestimasi pengaruh penggunaan input dan penerapan PHT dan Non PHT terhadap produksi padi. Analisis yang digunakan dalam penelitian ini adalah fungsi produksi Cobb-Douglas dengan metode regresi linear berganda. Secara parsial masing-masing variabel luas lahan , benih, pupuk anorganik dan variable dummy petani PHT atau Non PHT berpengaruh nyata terhadap produksi padi sawah di Kecamatan Kampar. Variabel pupuk organik, pestisida alami, pestisida alami diinteraksikan dengan frekuensi, pestisida kimiawi, pestisida kimiawi diinteraksikan dengan frekuensi dan tenaga kerja secara parsial tidak berpengaruh nyata terhadap produksi padi sawah di Kecamatan Kampar. Perlu digiatkan kembali penyuluhan tentang Pengendalian Hama Terpadu (PHT) di Kecamatan Kampar Kabupaten Kampar, karena dengan semakin berkembangnya kesadaran manusia terhadap bahaya penggunaan pestisida, terutama bagi lingkungan hidup dan kesejahteraan manusia, maka pengendalian OPT mengedepankan pengendalian secara preventif dengan menerapkan prinsip-prinsip PHT.*

Kata kunci: *Cobb-Douglas, organisme pengganggu tanaman, pengendalian hama terpadu, Non PHT, produksi padi*

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INTRODUCTION

Continuous increase in the production of agricultural products is one of the government's efforts to develop agriculture towards resilient agriculture because the agricultural sector plays a vital role as the primary source of life and income for agricultural society (Muzdalifah, 2011). In general, there are three ways to increase farm production, namely: (1) increasing the use of inputs, such as land, seeds, fertilizers, labor, and variations in capital, (2) applying new technology, and (3) managing production organizations with the available technology to increase production efficiency (Li, 2000). According to Emanuel (2022), the availability of rice affects food security, while the price does not. Rice is a basic need, so a price change does not affect food security in society.

Kampar District is one of the paddy rice producers in Riau Province. In 2021, the harvested area of paddy fields in Kampar District reached 6,535.8 ha with a production of 31,717.0 tons and a productivity of 4.85 tons/ha (DTPHPR, 2022). It is estimated that the population of Kampar District in 2022 will be 761,567, with an average current growth rate of 3.3%. The average level of public rice consumption is 108.74 kg per capita per year, so the average need for rice is 82,812.8 tons annually. Thus, there is still a lack of rice in the amount of 51,096 tons or 60% per year (PPID, 2021).

The attack levels of plant pest organisms (PPO) highly influence the productivity of paddy rice farming. The result of The Cost Structure of Horticultural Cultivation Household Survey by BPS (2017) showed that in efforts to control PPO attacks on paddy rice, 89.39% of households carried out PPO control both chemically/pesticide (79.24%), mechanically (4.26%), agronomically (5.03%), and biologically (0.86%) (BPS, 2017). The assumption is that the tendency for Riau Province to control PPO is more or less the same as at the national level, where the main pest control method with the largest percentage is using chemical pesticides. The main PPOs in Kampar Subdistrict during the October-March planting season are golden snails, stink bugs, rats, birds, and blasts.

With the increasing human awareness of the dangers of using pesticides, especially for the environment and human health, PPO control prioritizes preventive control by applying the principles of integrative pest management (IPM), which prioritizes the application of healthy crop cultivation, routine observation, utilization of natural enemies and farmers as IPM experts.

Referring to the problem of the increasing use of chemical pesticides by farmers, which will have an impact on the economy of an agricultural business, as well as environmental damage and other social problems, this research begins with the question of what inputs are used by paddy rice farmers who apply IPM compared to non-IPM and how the effect of input management application on production. The use of inputs by farmers in production activities can affect the resulting production and the level of productivity and provide an overview of the efficiency level that farmers achieve (Kumbhakar, 2002; Prayoga, 2010).

Several empirical studies related to the use of inputs in production activities include research by Prasaja et al. (2017), which states that farmers use seeds and chemical pesticides in non-IPM areas, while fertilizers (manure, Urea, Phonska), natural pesticides and labor outside the family are used more by farmers in IPM areas. Madau (2005); Yasin (2014); Tian (2011); Rubinos (2007); Conscience (2014); and Gultom (2014) concluded that the factors that positively and significantly influence the production and efficiency of paddy rice farming are land area, seeds, use of fertilizers, pesticides, and labor. Singbo et al. (2015) studied the efficiency of production inputs and the use of pesticides for vegetable production in Africa. The results showed that vegetable producers were less efficient in using pesticides than other inputs. In addition, the results show that pesticides, land and fertilizers are overused.

This research completed the research gap in previous studies, which compared the effect of the use of inputs and how input management is applied to production between farmers who apply IPM and non-IPM, especially in Kampar District, Riau Province. Soekartawi (2002) suggests that the combination choice of optimal use of labor, seeds, fertilizers, and medicines will get maximum results. In other words, combining inputs can create more efficient production. Mahadevan (2002), Madau (2005), Yasin (2014), Tian (2011), Rubinos (2007), Conscience (2014), and Gultom (2014) concluded that the factors that significantly influence the production and efficiency of paddy rice farming are land area, seeds, use of fertilizers, pesticides, and labor. This study aimed to identify the effect of input management applications and integrated pest control on paddy rice production in Kampar Subdistrict, Kampar District, Riau Province.

METHODS

The research was conducted in Kampar Subdistrict, Kampar District, Riau Province. The location selection is carried out purposively with several considerations: (1) Kampar District is one of the paddy rice producers in Riau, according to the data from the Food Crops and Horticulture Service of Riau Province (2019). The harvested area of paddy rice fields in Kampar District in 2018 reached 8,147 ha, producing 31,717 tons; (2) The condition of agricultural land is relatively not much different between the land used in paddy rice farming that applies IPM and non-IPM. These criteria are intended to obtain a variety of information related to land area and land ownership status in the research location and to avoid productivity differences caused by differences in the level of fertility of agricultural land. The Subdistrict in Kampar District that is considered to meet these criteria is Kampar Subdistrict. Kampar Subdistrict consists of 18 villages and one urban village and has a paddy rice field area of 851 Ha. The population of farmer group members in Kampar Subdistrict is 2,891 people, including 43 farmer groups. This research was conducted when paddy rice farmers entered the second planting season, so the observation is on the analysis of farming in the previous planting season, which is the first planting season (dry season). The first planting season is usually between April-September and the second (rainy season) in October-March. Data collection was carried out from October 2021 to March 2022.

The data used in this study is primary data collected from direct interviews with paddy rice farmers using a structured questionnaire. The collected primary data includes the characteristics of farmers and paddy rice farming in one season. Secondary data was also collected from the Food Crops and Horticulture Services of Riau Province and Kampar District, Farmers Group Annual Report Data, and Subdistrict Offices, to support and improve the analysis in this study.

The sampling method used in this study was purposive sampling. The research sample is farmers who apply paddy rice farming with IPM and non-IPM methods which are chosen purposively. Respondents, farmers who apply the IPM and non-IPM methods, are selected from farmer groups located in several villages in Kampar Subdistrict. Farmers who apply paddy rice farming using the IPM method are identified by members of the farmer group who had attended SL-IPM and/or implemented IPM principles in paddy rice farming.

The number of IPM farmers in Kampar District is 127 farmers (BPP Kampar Subdistrict, 2020). Through observation, only 38 farmers were doing IPM paddy rice farming, so the sampling for IPM farmers was carried out by census or as a whole. Then as a comparison, 62 farmers were selected purposively as non-IPM farmer respondents. Thus, the total sample to be researched was 100 farmers.

Analysis of the Effect of Input Management on Rice Paddy Production

The production factor needs to be considered in running a farming business because it will determine the resulting production. Using the right production factors can increase production so that the resulting productivity will also be high. Production factors such as land, capital to buy seeds, fertilizers, pesticides and labor as management aspects are essential factors in farming.

The relation between the production factor (input) and production (output) is called the production function. The production function used in this study is the Cobb-Douglas production function with a multiple linear regression method. The Cobb-Douglas production function can describe the elasticities of production inputs used as independent variables. Thus, it is expected that farmers can plan the proper use of input variables to produce high production in their farming. The Cobb-Douglas production function is also able to describe the return to scale. Return to scale can describe the farmers' ability to produce paddy rice so that farmers can find out the paddy rice farming is being carried out at which level return of scale, increasing, constant, or decreasing. According to Debertin (1986), the production function is divided into three production areas distinguished based on the production elasticity of the factors. They are production areas with production elasticity greater than one (area I), production areas with elasticity between zero and one (area II), and production areas with production elasticity less than one (area III). The production function used by Mulyati (2014), Gultom et al. (2014), Neonbota dan Kune (2016), Sularso and Stanto (2020), Ma'ruf et al. (2019), as well as Leovita and Martadona (2021), explain the relation between production and production factors that affect using Cobb-Douglas production function. Research by Mulyati (2014) regarding the analysis of production and income of lowland paddy rice farming using the Cobb-Douglas production function analysis method shows simultaneously the independent variables of land area, seed, Urea, Phonska, labor, farmer age, farming experience, and level of farmer education has a significant effect on paddy rice farming, while partially it shows that the independent variables that have a significant effect are land area, seeds, Urea, and farming experience. Different from the research by Neonbota and Kune (2016), partially, the variables of fertilizer, labor, and capital have a positive and significant influence on paddy rice farming. Meanwhile, the variables of land area, seed, experience and education have no significant effect on the production of lowland rice farming.

Research by Walis et al. (2021) shows that only land area and urea fertilizer are the independent variables that significantly affect paddy rice production. Another study by Sularso and Sutanto (2020) shows that the variables of seeds, manure, liquid organic fertilizer, liquid organic KCL fertilizer, and its use of nutrients can increase productivity, while labor causes a decrease in the productivity of organic paddy rice and pesticides have no effect on increasing or decreasing production. Labor does not affect the increase or decrease in production because the use of labor exceeds the recommended limit.

The independent variables used in this study are land area, seeds, organic fertilizer, inorganic fertilizer, organic pesticides interacted with frequency, chemical pesticides, chemical pesticides interacted with frequency, labor variables and dummy variables of IPM and non-IPM farmers on paddy rice production. The variables are selected based on literature studies and previous research on production. It is adjusted to field conditions and production input used by the IPM and non-IPM farmers in Kampar Subdistrict.

The production function model is transformed into a linear, logarithmic form to make it easier to analyze and process the data. The linear form of the function is as follows:

$$\ln Yi = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5(\ln X_{5i}) + \beta_6(\ln X_{5i} * X_f) + \beta_7(\ln X_{7i}) + \beta_8(\ln X_{7i} * X_f) + \beta_9 \ln X_{9i} + \beta_{10}(\ln D_{10i}) + \varepsilon_i$$

description: Y (total production of IPM rice (kg of harvested wet grain)); X_1(land area (ha)); X_2 (seeds (kg)); X_3 (organic fertilizer (kg)); X_4 (inorganic fertilizer (kg)); X_5 (natural pesticides (liter)); X_6 (natural pesticides* frequency (liter)); X_7 (chemical pesticides (liter)); X_8 (chemical pesticides* frequency (liter)); X_9 (labor (HOK)); D_{10} (Dummy Variables (1=petani PHT, 0=petani non PHT); Xf (Frequency Interaction Variable); β_1(intercept); β_1, β_2, β_3, β_4, β_5, β_6, β_9, β_{10} (estimated parameters); ε (error).

Expected parameter coefficient value:
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_9, \beta_{10} > 0$
$\beta_7, \beta_8 < 0$

To get the best and unbiased regression equation model, it must meet the Ordinary Least Square (OLS) requirements (Gujarati, 2006). The tests must meet the OLS assumptions as follows:

Normality Test

The Normality Test measures whether data has a normal distribution that can be used in parametric statistics. According to Sugiyono (2017), the normality test is a test to see whether the residuals obtained have a normal distribution. The statistical test in this study used the Kolmogorov-Smirnov test. If the significance value of the Kolmogorov-Smirnov test is > 0.05, then the residuals are normally distributed, and vice versa.

Multicollinearity Test

Multicollinearity is a linear relationship between independent variables. Ghozali (2017) stated that the multicollinearity test aims to test whether there is a high or perfect correlation between the independent variables in the regression model. A good regression model should not correlate with the independent variables. If the independent variables are correlated, then these variables are not orthogonal. Orthogonal is the relationship between two or more factors or variables that are mutually independent or uncorrelated. In experimental design, when two factors or variables are said to be orthogonal, a change in one factor or variable will not affect the results or measurements related to the other factor or variable. Multicollinearity can be known from the tolerance value and Variance Inflation Factor (VIF). The regression is free from multicollinearity if the tolerance value is greater than 0.1 and the VIF value is less than 10.

Autocorrelation Test

According to Suryani and Hendryadi (2015), the autocorrelation test aims to test whether there is a correlation between the confounding errors in the regression model period t with confounding errors in period t-1 or previous. This test can be carried out through the Durbin-Watson test. If the DW value lies between the upper limit or upper bound and the critical limit (0.05) from the DW table, it can be concluded that there is no autocorrelation. The decision to reject or accept the null hypothesis is given in the following Figure 1.

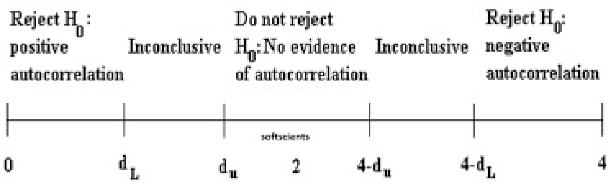

Figure 1. The decision to reject or accept the null hypothesis

Heteroscedasticity Test

This heteroscedasticity test aims to test whether there is an inequality of variance from the residuals of one observation to another in the regression model. If the variance from one observation to another is constant, it is called homoscedasticity, or heteroscedasticity does not occur, while it is called heteroscedasticity if the variance is different. A good regression model has homoscedasticity or does not have heteroscedasticity (Ghozali, 2001). The Heteroscedasticity test in this study can be carried out using graphical analysis methods to detect heteroscedasticity problems. This graphical method is carried out by looking at the graph plot between the predicted value of the dependent variable called ZPRED and the residual SRESID (Ghozali, 2017).

RESULTS

Before interpreting the results of research data processing, it is necessary to ensure that the model used is the best. In this study, the evaluation of the model was carried out through the classical assumption test. The results of the assumption tests to comply with existing assumptions, such as the normality test, multicollinearity test, autocorrelation test and heteroscedasticity test, are as follows:

1. The normality test results obtained a significant value of 0.079 > 0.05 for the production variable, so the data is normally distributed.
2. For the multicollinearity test, the VIF value for each variable in the model is <10, and the tolerance value is > 0.01, so the regression model is declared to have no indications of multicollinearity.
3. For the autocorrelation test, the DW value is 1.959 at a 5% degree of confidence, the number of independent variables (k = 10) and a sample of 100 respondents gives a dU value (upper limit) of 1.898 and a dL value (lower limit) of 1.462. The condition for no autocorrelation is dU<DW<4-dU, 1.898<1.959<2.102, so it can be concluded that autocorrelation does not occur.
4. For the heteroscedasticity test, the plot graph between the predicted value of the dependent variable ZPRED and the residual SRESID shows no heteroscedasticity in the regression model, so it is feasible to use.

Analysis of Production Input Use

Table 1 shows that Fcount = 20.715 > Ftable = 1.927 with a significant value of 0.000 <0.10, proving that the null hypothesis (H0) is rejected. The alternative hypothesis (H1) can be accepted at α = 10%, meaning that the independent variable is the land area (X1), seeds (X2), organic fertilizers (X3), inorganic fertilizers (X4), natural pesticides (X5), natural pesticides* frequency (X6), chemical pesticides (X7), chemical pesticides*frequency (X8), labor (X9)), IPM or Non-IPM farmers (D10) simultaneously (together) affect lowland paddy rice production in Kampar subdistrict, Kampar District.

The adjusted coefficient of determination (R2) of 69.9% indicates that the variation in rice production factors (Y) can be explained by the independent variable land area (X1), seeds (X2), organic fertilizers (X3), inorganic fertilizers (X4), pesticides natural pesticides (X5), natural pesticides*frequency (X6), chemical pesticides (X7), chemical pesticides*frequency (X8), labor (X9), IPM or Non-IPM farmers (D10). Meanwhile, 30.1% is explained by factors not included in the model, such as climate, pest attacks and others (Table 2).

Land Area (X_1)

The variable land area (X_1) significantly affects the production of lowland paddy rice farming in the Kampar Subdistrict, where the sig value is 0.000 <0.01 at the level α = 1% two-way test. The increasing area of land cultivated by farmers will affect paddy rice production. Expanding land area means it will increase the total population of lowland paddy rice, increasing its production, assuming other production factors are constant. It can happen because the land area in Kampar Subdistrict still allows for expansion of the paddy rice farming area. It follows the results of Emalia and Tavi (2021) that land area significantly affects the production of lowland paddy rice farming. The larger the land farmers cultivate, the more positive impact it will have on production. The results of this study are also in accordance with research by Asogwa and Simon (2011), Alvares and Arias (2004) and Rahmat et al. (2017) that farmers with large land areas will produce a lot if the land is appropriately managed to earn high income. Otherwise, farmers with small land will produce a few, especially if not managed properly.

The results showed that the area of paddy fields significantly affected production. The average area of paddy land managed by IPM farmers is 0.37 Ha, while non-IPM farmers are 0.31 Ha. Smallholders with less than 1 hectare of land can increase production by maximizing the use of available land. The following are some paddy land management strategies that can be applied:

1. Selecting rice varieties suitable for the field: Varieties suitable and resistant to pests can produce better yields and are more resistant to local environmental conditions.
2. Manage weeds well: Using the right herbicides and regular weeding can help solve weed problems.

Table 1. Analysis of the factors influencing lowland rice production in Kampar Subdistrict, Kampar District, 2022

Model	Df	Squared sum	Middle square	Fcount	Sig.
Regression	10	29400170.97	2940017,097	20.715	.000[b]
Residual	89	12631278.87	141924,482		
Total	99	42031449.84			

[a]Dependent: Ln_Y

[b]Predictors (Constant), Ln_X10, Ln_X2, Ln_X3, Ln_X8, Ln_X9, Ln_X4, Ln_X1, Ln_X5, Ln_X7, Ln_X6

Table 2. Regression coefficient of production factors of lowland paddy rice in Kampar District 2022

Description	Regression Coefficients	tcalculated	Sig.
Constant	-114.891	-0.599	0.551
Land Area	964.598	4.431	0.000***
Seed	13.472	3.711	0.000***
Organic Fertilizer	0.073	0.198	0.844
Inorganic Fertilizer	4.036	5.402	0.000***
Natural Pesticide	10.972	1.127	0.263
Pesticide*Freq	3.725	0.932	0.354
Chemical Pesticide	-37.783	-1.659	0.101
Chemical Pesticide*Freq	-27.198	-.833	0.407
Labor	2.711	0.440	0.661
IPM and non-IPM	232.373	1.853	0.067*
R^2 = 0.699			
T_{tabel} = 1.660 (α = 10%)			

Note: Significance levels of α* = 10%; α** = 5%; and α*** = 1%

Seeds

The seed variable (X2) has a significant effect with a positive coefficient on the lowland paddy rice production in Kampar Subdistrict. Increasing the number of seeds used will also increase the total population of lowland paddy rice. An increase in the total lowland rice population tends to increase the amount of lowland paddy rice production, assuming other production factors are sufficient.

Through observation, the average use of seed in IPM farming is 65.27 kilograms per hectare, while non-IPM farming is 113.40 kilograms per hectare. It is recommended that 15 kg seeds are required if one seed is planted per hole, while 25 kg/ha is usually needed if 3–4 seeds are planted per hole. The high use of seeds in the Kampar Subdistrict is due to land conditions, the environment, and the repeated use of certified or local seeds. The paddy fields in Kampar Subdistrict are rain-fed, which will be flooded and get golden snail attacks during the rainy season. Otherwise, mole crickets pests are faced in the dry season. To overcome these problems, farmers in Kampar District sow more seeds than recommended. Thus, when they get attacked by golden snails or mole crickets pests, they can insert seeds until the paddy rice is 30 HST.

The paddy rice seeds used by farmers in Kampar District are local seeds, local superior seeds and certified seeds. Certified seeds and local superior seeds have better germination compared to local seeds. According to Ruskandar (2015), the high use of unlabeled seeds in Kampar District and limited kiosks in an area are among the reasons for the late spread of VUB. Thus, sometimes they only rely on the institution. In Kampar District, more farmers use local or local superior seeds that have been planted repeatedly, as well as blue-labeled seeds that have been used frequently. Meanwhile, the instruction for the blue-labeled paddy rice seeds can only be used once so that the production probability will be low.

The results showed that using paddy rice seeds has a significant positive effect on rice production, so farmers need to consider using the right seeds to increase productivity and crop quality. The following are some strategies for managing the use of seed inputs that can be implemented:

1. Choose quality paddy rice seeds: Quality paddy rice seeds have good growth potential and can adapt to local environmental conditions.
2. Select good paddy rice seeds: Farmers can select good paddy rice seeds from previous harvests. Choose large, healthy, and unblemished grain or paddy rice seeds as seed material for the next harvest.

Inorganic Fertilizers

The inorganic fertilizer variable (X4) significantly affects paddy rice production in Kampar Subdistrict. Inorganic fertilizers contain one or more inorganic compounds (Leiwakabessy and Sutandi, 2004). Fertilizer recommendations by the government through the Ministry of Agriculture based on agronomic field test a national general recommendation without considering the soil properties and plant needs. Based on the Regulation of the Minister of Agriculture No. 40/Permentan/OT.140/4/2007 concerning Recommendations for N, P, and K Fertilization in Location-Specific Lowland Paddy Rice, NPK (15-15-15) 150-250 kg, additional single fertilizer Urea 150 -200 kg, KCL 25-75 kg.

The use of inorganic fertilizers for IPM farming is 67 kg per hectare, while non-IPM farming is 47.44 kg. The composition of fertilizer use in Kampar District, out of the total use of chemical fertilizers, is Urea at 41%, NPK at 30.6%, TSP at 9.9%, KCl at 11.50%, ZA at 1.7% and SP36 at 4.6%. The use of chemical fertilizers in Kampar District is still not optimal, especially for flood-prone areas. During the rainy season, farmers usually do not use fertilizer at all because paddy fields will be submerged, so fertilizer becomes non-existent and redundant.

In line with the results of research by Siwanto et al. (2015), the application of doses of up to 1,000 kg of organic fertilizers/ha resulted in low growth and yields. The increasing application of doses up to 400 kg of inorganic fertilizers/ha increased the growth and yield of lowland paddy rice. The highest N efficiency was 89.19% at the application dose of 500 kg organic fertilizer/ha + 200 kg inorganic fertilizer/ha. In comparison, the highest P and K efficiency were 69.55% and 92.52% at the application dose of 750 kg organic fertilizer/ha + 300 kg inorganic fertilizer/ha.

It is recommended that farmers take the fertilizer recommendations provided by agricultural experts and take good care of the plants to increase productivity and reduce the risk of pest and disease attacks. Some strategies for managing the use of inorganic fertilizers are as follows:

1. Paying attention to the right dose: Farmers need to pay attention to the right dose of inorganic fertilizer so that over-dose or under-dose does not occur.
2. Using the right type of fertilizer: Farmers need to use the right fertilizer for paddy rice plants. Choose fertilizers that contain the nutrients needed by paddy rice plants, such as nitrogen (N), phosphorus (P), and potassium (K).
3. Applying the right application technique: Farmers need to apply the right fertilizer application technique so that the paddy rice plants can adequately absorb the fertilizer.

IPM and Non-IPM

The dummy variable, whether farmers implement IPM or non-IPM, has a significant effect with a positive coefficient on the paddy rice farming production in the Kampar subdistrict, where a significant value is 0.067 > 0.10 at the level of $\alpha = 10\%$ two-way test.

The introduction of IPM technology began with training for officers to be passed on to farmers under the name Integrated Pest Management Field School (SL-IPM). It is expected that SL-IPM alumni farmers will be able to apply IPM technology on their farming land and disseminate it to other farmers. They become partners in the dissemination of IPM technology. IPM farmers in Kampar Subdistrict have mostly attended IPM Field Schools and are included in farmer groups. They also transfer their knowledge to other farmers so that although some farmers have never participated in SL-IPM, by observing IPM farmers and attending counseling in their farmer groups, they can be included in the category of IPM farmers.

The results of research conducted by Bueno et al. (2011) showed that the productivity of soybean plants was always higher when IPM was used, including the preferential application of selective products, which were applied only when necessary. Thus, adopting IPM with rational use of insecticides with a low impact on the environment reduces the application of synthetic products in crop fields (Meissle et al. 2010; Tang et al. 2010). IPM farmers in the field can become managers in their land. They combine measures that consider economic and environmental aspects in OPT control decisions. IPM farmers will still use pesticides as a final step if other preventive measures do not work. Irham and Mariyono (2001) show that IPM can increase the knowledge and skills of farmers indirectly as well as bring a positive impact on the environment and the economy because it reduces the use of pesticides.

The appropriate management strategies that can help farmers apply the IPM concept and increase productivity are as follows:

1. Counseling and training: In counseling and training, farmers can be given explanations related to proper IPM techniques and how to apply the IPM concept to their farms.
2. Development of IPM community networks: These communities can be a tool for farmers to share experiences and knowledge in applying the IPM concept to their farms.

Managerial Implications

1. Land use management: Farmers need to pay attention to the area of land used in paddy rice production. Production efficiency, fixed cost reduction, and production diversification are ways to increase economies of scale. While there are benefits of economies of scale in rice production using a larger land area, farmers must also consider the limitations.
2. Seed use management: Farmers need to select quality seeds suitable for soil and climatic conditions at the production site.
3. Inorganic fertilizers use management: Inorganic fertilizers must be used in accordance with the recommendations of agricultural experts to prevent excess or deficiency of nutrients that can negatively impact growth and crop yields.
4. IPM Management: With the increasing human awareness of the dangers of using pesticides, especially their impact on the environment and human welfare, the Regional Government of Kampar District needs to re-enact counseling on Integrated Pest Management (IPM).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Land area, seeds, organic fertilizers, inorganic fertilizers, natural pesticides, natural pesticides interact with frequency, chemical pesticides, chemical pesticides interact with frequency, labor, the application of IPM or Non-IPM simultaneously (together) affect paddy rice production in Kampar subdistrict, Kampar district. Partially, each variable land area, seeds, inorganic fertilizers and dummy variables of IMP or Non-IPM farmers significantly affected lowland paddy rice production in Kampar Subdistrict.

The application of IPM or Non-IPM has a significant effect on paddy rice production in Kampar subdistrict, Kampar District. It shows that paddy rice production is always higher when IPM is used. Farmers who apply IPM in PPO control prioritize preventive control by applying IPM principles, which prioritize the application of healthy crop cultivation, routine observation, utilization of natural enemies and farmers as IPM experts. IPM farmers will still use pesticides as a final step if other preventive measures do not work, with the application of IPM will help prevent crop failure.

Recommendations

The study was conducted in two growing seasons (rainy and dry seasons), so the information could be obtained on the use of production inputs in both seasons because OPT attacks will be different in both seasons, affecting farmers' decisions to use production inputs. Study on the effect of natural and chemical pesticide doses on paddy rice production: This research can evaluate the most optimal doses of pesticides to be applied in paddy rice farming. Study of the effect of IPM on sustainable farming systems: This research can evaluate the ability of IPM to increase agricultural productivity and environmental balance and find the best way to implement it in sustainable farming systems. Development of input management and IPM application model: This research can develop a model of input management and application of appropriate IPM for effective and efficient paddy rice farming. This model can guide farmers to optimize the application of IPM in their paddy rice farming.

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REFERENCES

Alvarez A, Arias C. 2004. Technical efficiency and farm size: a conditional analysis. *Agricultural Economics* 2(30): 241-250. https://doi.org/10.1111/j.1574-0862.2004.tb00192.x

Asogwa J and Simon. 2011. Economic efficiency of nigerian small scale farmers. *Journal of Economics* 2(2): 89-98. https://doi.org/10.1080/09765239.2011.11884940

[BPP] Balai Penyuluhan Pertanian Kecamatan Kampar. 2020. *Programa Penyuluhan Pertanian Tahun 2021.* Kampar: BPP.

[BPS] Badan Pusat Statistik. 2017. *Survei Struktur Ongkos Usaha Tani Tanaman Pangan tahun 2017.* Jakarta: BPS.

Emalia R, Tavi S. 2021. Pengaruh input produksi terhadap pendapatan melalui produksi padi sawah di Desa Sitanggor, Kecamatan Muara, abupaten Tapanuli Utara. *Jurnal Agrosains dan Teknologi* 28(2).

Bueno RCOF, Bueno AF, Moscardi F, Parra JRP, Hoffmann-Campo CB. 2011. Lepidopteran larvae consumption of soybean foliage: basis for developing multiple-species economic thresholds for pest management decisions. *Pest Management Science* 66: 170-174. https://doi.org/10.1002/ps.2047

Cooper J, Dobson H. 2007. The benefits of pesticides to mankind and the environment. *Crop Protection* 26:1337–1348. https://doi.org/10.1016/j.cropro.2007.03.022

Debertin DL. 1986. *Agricultural Production Economics.* New York: Macmillan Publishing Company.

[DTPHPR] Dinas Tanaman Pangan dan Hortikultura Provinsi Riau. 2022. *Buku Seri Data Tanaman Pangan dan Hortikultura Provinsi Riau tahun 2022.* Pekanbaru: DTPHPR.

Emmanuael Be. 2022. Impact of rice production, rice supply and rice price on food security in North Timor District. *Jurnal Manajemen dan*

Agribisnis 19(3): 407-417.

Ghozali I. 2017. *Model Persamaan Struktural Konsep Dan Aplikasi Program AMOS 24.* Semarang: Badan Penerbit Universitas Diponegoro.

Gultom L. 2014. Analisis efisiensi teknis usahatani padi semi organik di Kecamatan Cigombong Kabupaten Bogor [tesis]. Bogor: IPB.

Gujarati D.2006. *Dasar-Dasar Ekonometrika.* Jakarta: Erlangga

Hasibuan M, Manurung ED, Lely ZN. 2021. Pemanfaatan daun mimba (*Azadirachta indica*) sebagai pestisida nabati. *Agrista: Jurnal Ilmiah Mahasiswa Agribisnis* 5(1): 1153–1158.

Irham, Mariyono J. 2001. Usaha menurunkan penggunaan pestisida sintetik dengan program pengendalian hama terpadu. *Manusia dan Lingkungan* 8(1): 30–36.

Kumbhakar SC. 2002. Specification and estimation of production risk, risk preferences and technical efficiency. *American Journal of Agricultural Economics* 84(1):8-22. https://doi.org/10.1111/1467-8276.00239

Leovita A, Martadona I. 2021. Faktor-faktor yang mempengaruhi produksi padi di Kecamatan Kuranji Kota Padang Provinsi Sumatera Barat. *Jurnal Ilmiah Indonesia* 6(5):177-182. https://doi.org/10.37149/jia.v6i5.20817

Li LP. 2000. Yield Gaps, Economic inefficiency and potential for productivity growth of rice farms in China [Dissertation]. University of the Philippines.

Ma'aruf MI, Kamarudin CA, Muharief A. 2019. Analisis pendapatan dan kelayakan usahatani padi di Kecamatan Pitu Riawa Kabupaten Sidrap. *Jurnal Sosial Ekonomi Pertanian* 15(3):193-204. https://doi.org/10.20956/jsep.v15i3.7021

Madau FA. 2005. Technical efficiency in organic farming: an application on italian cereal farms using a parametric approach. Paper Prepared for Presentation at the XI th Congress of the Eroupean Association of Agricultural Economists. *The Future of Rural Europe I the Global AgriFood Sistem, Copenhagen.*

Mahadevan, R. 2002. A Frontier approach to measuring total factor productivity growth in Singapore Service's Sector. *Journal of Economic Studies* 29(3): 48–58. https://doi.org/10.1108/01443580210414111

Meissle M, Musa T, Mouron P, Bigler F. 2010. Pest, pesticide use and alternative options in European maize production: current status and future prospects. *Journal of Applied Entomology* 134(5): 357–375. https://doi.org/10.1111/j.1439-0418.2009.01491.x.

Mulyati H. 2014. Analisis produksi dan pendapatan usahatani padi sawah Desa Jono Oge Kecamatan Sigi Biromaru Kabupaten Sigi. *e-J. Agrotekbis* 2(1):54-61.

Musdalifah. 2011. Analisis produksi dan efisiensi usahatani padi di Kabupaten Banjar. *Jurnal Agribisnis Perdesaan* 1(4): 1-20.

Neonbonta SL, Kune SJ. 2016. Faktor yang mempengaruhi usahatani padi sawah di Desa Haekto Kecamatan Noemuti Timur. *Jurnal Agribisnis Lahan Kering* 1(3):32-35. https://doi.org/10.32938/ag.v1i03.104

Nurani LE. 2014. Analisis efisiensi teknis padi organik di Kabupaten Bogor [tesis]. Bogor: Institut Pertanian Bagor.

[Permentan] Peraturan Mentri Pertanian Republik Indonesia Nomor 40/Permentan/OT.140/4/2007 tahun 2007 tentang Rekomendasi Pemupukan N, P, dan K pada Padi Sawah Spesifik Lokasi.

[PPID] Pejabat Pengelola Informasi dan Dokumentasi Daerah Kabupaten Kampar. 2021. Buku profil daerah Kabupaten Kampar tahun 2021. https://ppid.kamparkab.go.id/public/dokumen/2022/12/686aabe68a664895a8e3b18d9aad7cc2.pdf

Rahmat, Alam, MN, Yulianti K. 2017. Analisis efisiensi penggunaan input produksi pada usahatani padi sawah di Desa Posona Kecamatan Kasimbar Kabupaten Parigi Moutung. *e-J.Agrotekbis.* 5(1): 119 -126.

Rubinos R, Theresa A, Bayacag P. 2007. Comparative economic study of organic and conventional rice farming in Magsaysay, Davao del Sur. *10th national convention on statistiks (NCS)*, EDSA Shangri-La Hotel, Manila.

Ruskandar A. 2015. Pemanfaatan benih padi berlabel di tingkat Petani Riau. *Jurnal Agrijati* 28(1): 145-157.

Shende NV, Bagde NT. 2013. Economic Consequence of Pesticide Use in Paddy Cultivation. *American International Journal of Research in Humanities, Arts and Social Sciences* 18(4): 80–89.

Singbo AG, Lansink AO, Grigorios E. 2015. Estimating shadow prices and efficiency analysis of productive inputs and pesticide use of vegetable production. *European Journal of Operational Research* 245(1): 265–272.

Siwanto T, Sugiyanta, Maya M. 2015. Peran pupuk organik dalam peningkatan efisiensi pupuk anorganik pada padi sawah (Oryza sativa L.). *Indonesian Journal of Agronomy* 43(1): 8-14.

Sjukur D. 2020. Manfaat pupuk organik terhadap produktivitas lahan pertanian. www//pertanian.go.id. Penyuluh Pertanian Madya. DTPHBUN Provinsi Sulawesi selatan.

Soekartawi. 2002. *Teori Ekonomi Produksi*. Jakarta: Raja Grafindo Persada.

Sugiyono. 2017. *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: CV. Alfabeta.

Suryani, Hendryadi. 2015. *Metode riset kuantitatif teori dan aplikasi pada penelitian bidang Manajemen dan Ekonomi Islam.* Jakarta: Kencana Prenadamedia Group.

Sularso KE, Sutanto A. 2020. Efisiensi teknis usahatani padi sawah organik di Kabupaten Banyumas. *Jurnal Agribisnis Indonesia* 8(2):142–151.

Tang S, Cheke RA, Tang G. 2010. Optimum timing for integrated pest management: Modelling rates of pesticide application and natural enemy releases. *Journal of theoretical Biology*. 264(2):623-638. https://doi.org/10.1016/j.jtbi.2010.02.034

Tien. 2011. Analisis efisiensi teknis usahatani padi sawah aplikasi pertanian organik. *El-Hayah*1(4):182–190.

Walis NR, Setia B, Isyanto AY.2021. Faktor-Faktor yang Berpengaruh terhadap Produksi Padi di Desa Pamotan Kecamatan Kalipucang Kabupaten Pangandaran. *Jurnal Ilmiah Mahasiswa Agroinfo Galuh* 8(3): 648–657. https://doi.org/10.25157/jimag.v8i3.5419

Yasin M, Ashfaq, Adil, and Bakhsh. 2014. Profit efficiency of organic vs conventional wheat production in rice-wheat zone of Punjab, Pakistan. *Indonesian Journal of Agricultural Research* 52(3):431–452.