Landscape integrated pest management as a tool to determine the risk of production of rice farming in Pliken Village Banyumas Regency

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Abstract. Landscape IPM has been developed in a certain region in Java to strenghten the ecosystem that has been impacted by the massive utilization of pesticide during long period. This study was held to: 1) Testify if there is any significant difference between the production of LIPM adopters and non-LIPM adopters, 2) Compare the level risk of production between LIPM adopters and non-adopters, 3) Analyze the determinant factors of risk of production. Independent two-sample T-Test and scatter plot were used to determined if there is any significant difference between the two categories, while the level of risk of production were measured by calculation of Coefficient of variation (CV). The determinant factors of risk of production analyzed by using multiple linear regression based on the method of multiplicative heterocedastic. The result shows that there is no significant difference between the production of LIPM adopters and non-adopters, but indeed it has a lower level risk of production. One factor that has significantly influenced the risk of production is pest attack.

1. Introduction

Today's conventional farming system has begun to decrease in number, replaced by an agricultural system that is more directed to environmentally friendly agriculture which puts forward the concept of environmental conservation. This is certainly in line with the United Nations program namely Sustainable Development Goals (SDGs) which consider environmental aspects in all national development sectors. The emergence of the SDGs program is a form of concern for the various challenges faced by humanity such as climate change, environmental degradation, poverty, and inequality of development.

In the agricultural sector, degradation of land fertility is one of the main problems that can have a major impact on the decline in land productivity. Some things that led to a decline in the level of land fertility were the application of excessive chemical fertilizers and pesticides by the main actors of the agricultural sector, namely farmers. Farmers have a desire to increase the quantity and quality of their products so that application of chemical fertilizers and pesticides cannot be avoided. If there is a disturbance of pest in cultivated plants, farmers quickly decide to apply chemical pesticides as a solution to plant pest problems [1]. Pesticides play an important role and have a major contribution in the world of modern agriculture, especially in efforts to achieve food security for the community.
However, excessive application of pesticides will cause degradation of some aspects of the elements contained in the soil that cannot be ignored [4]. This of course will affect the productivity of crops cultivated on the land. Therefore the application of environmentally friendly agricultural systems needs to be considered to maintain and improve soil fertility. Therefore, an integrated pest control program (IPM) has been developed which integrates various environmentally friendly methods in controlling pest populations that attack farming land. The main objective of integrated pest control is to control pest populations against the production of cultivated plants in order to provide economic, social and environmental benefits. The techniques used can be in the form of chemistry, biology, culture, physics, genetics and regulation. In implementing it, one of the things that must be taken into consideration is the economic threshold. The economic threshold is stated as the point where the cost used to control pests is proportional to the results obtained after the pest control. This refers to the concept of profit maximization shown from conditions when marginal costs equal marginal products [2].

IPM in Indonesia was developed from the 1990s. Some researchers have conducted research on the effects of the adoption of IPM systems on agricultural land in Indonesia. One of the studies conducted by [5] sought to analyze the effect of the implementation of IPM on the demand for chemical pesticides in Java. Based on the results of his research, it was found that the implementation of IPM programs in several regions in Java, such as Yogyakarta and Central Java had a significant effect on reducing the level of demand for chemical pesticides by farmers. Currently IPM programs have been developed into landscape IPM. The difference between IPM and LIPM is that LIPM landscape is an effort to control pest disease on a wide scale. Farmers in Indonesia on average have narrow plots of land. Therefore, this program is implemented in the hope that farmers who have arable land in one stretch can work together in handling the pest that attacks. With mass control on a wide expanse, it is expected to get more effective and efficient results. But it cannot be denied, there are still many farmers who have not been moved to use the concept of landscape IPM on their land. Like what happened in Pliken Village. Some farmers are very enthusiastic about implementing the program, but others actually consider landscape IPM to be less beneficial for rice farming. To help farmers in making choices whether it would be better if they participated in the program or not, this study aimed at: 1) Testify if there is any significant difference between the production of LIPM adopters and non-LIPM adopters. 2) Compare the level risk of production between LIPM adopters and non-adopters. 3) Analyze the determinant factors of risk of production.

2. Materials and Methods
This study was purposively took place in Pliken Village, Banyumas District, Central Java Province, Indonesia. Pliken Village was chosen because it was one of those regions in Java that implemented the Landscape Integrated Pest Management (LIPM) through the IPM Training held by Food and Agriculture Organization (FAO) since 2014. The primary data which collected in September 2016 was including total 60 respondents divided in two categories: 30 LIPM adopters and 30 non adopters. The determination of sample sizes was using the assumption that the farmers in Pliken Village were mostly homogenous that 60 respondents were able to be the representative of overall condition of rice farmers there.

The t-test (Independent sample t-test) is used to determine whether there is a significant difference between the production of landscape IPM farming and non-IPM landscape farming. Therefore, the null hypothesis and alternative hypothesis of this test are:
Ho: There is no significant difference between the production of landscape IPM farming and non-IPM landscape farming
Ha: There is a significant difference between the production of landscape IPM farming and non-IPM landscape farming
The mean difference test can be known by the following formula [9]
Where:
\[ \mu_1 = \text{LIPM adopters mean of production} \]
\[ \mu_2 = \text{non LIPM adopters mean of production} \]
\[ S_1 = \text{standard deviation of LIPM adopters production} \]
\[ S_2 = \text{standard deviation of non LIPM adopters production} \]
\[ N_1 = \text{sample size of LIPM adopters} \]
\[ N_2 = \text{sample size of LIPM adopters} \]

When \( t \) value > \( t \) table so \( H_0 \) is being rejected, nevertheless if \( t \) value < \( t \) table so \( H_0 \) accepted.

Variability can be measured using the standard deviation (SD), which is defined as the square root of the variance of a set of potential production. It is a measure of dispersion, or spread of the outcomes, and also something that able to indicates risk in the sense that the wider the dispersion is, the more risk there is. Standard deviation is not a perfect measure of risk since its spread includes both good and bad outcomes. Nevertheless, it is an indicator of risk since it measures how far the worst outcomes may fall below the mean. Using this measure, the decision rule is to minimize the SD, that is, to reduce the dispersion of potential outcomes to its lowest possible level. The coefficient of variation defined as SD divided by EV. This risk measure combines variability and return in a very practical way. It still suffers from the same problem as minimizing the SD, since good and bad outcomes are both included in dispersion; however, it is very intuitive to compare the amount of dispersion to the EV [3].

\[ CV_p = \frac{\sigma_p}{\mu^*} \]  

Where:
\( CV_p = \text{production coefficient of variation} \)
\( \sigma_p = \text{production standard of deviation} \)
\( \mu^* = \text{mean of production} \)

The smaller coefficient of variation indicates lower data variability. This illustrates the lower risk conditions faced by farmers. If there are two production alternatives with different standard deviations and expected returns, it is necessary to calculate the coefficient of variation for the two alternatives. Alternatives that provide the lowest CV value can be taken into consideration in making decisions so that entrepreneurs can process their business so that they get the risk or the possibility of lower losses [6].

In addition, a deeper analysis of the factors that affect production risk is significantly carried out. Analysis of the influence of inputs on production risk is carried out by referring to the Just and Pope system. There are two stages of regression that must be done. The first is the regression of production functions with independent variables in the form of rice farming inputs and the dependent variable in the production of rice farming. Second is the production risk function with residuals derived from the regression of the production function as the dependent variable and farming input as the independent variable. The application of landscape IPM was included in the model as a dummy variable to see the influence of the application of landscape IPM on production risk. The function is then regressed using multiple linear regression using the Ordinary Least Square (OLS) method. Regression models that describe the effect of input use on production are generally written as follows:

\[ \ln Y_p = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \delta_1 D_{OPT} + \delta_2 D_{ref} + \mu_p \]  
\[ \ln \mu_p^2 = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \delta_1 D_{OPT} + \delta_2 D_{ref} + \mu \]
Where:
- \( Y_p \) = production of paddy field (kg)
- \( \mu_p \) = risk of production
- \( \mu \) = residual
- \( \beta_0 \) = intercept
- \( \beta_i \) = coefficient of regression (estimated parameter) \( (i = 1 \text{ s/d } 4) \)
- \( \delta_i \) = coefficient of regression dummy variable \( (i =1 \text{ s/d } 2) \)
- \( D_{\text{pest attack}} \) = pest attack \( (1 = \text{often attacked}; 0 = \text{rarely attacked}) \)
- \( D_{\text{refugia flower}} \) = plantation of refugia flower \( (1 = \text{LIPM adopters}; 0 = \text{non LIPM adopters}) \)
- \( X_1 \) = land size (m\(^2\))
- \( X_2 \) = seed (kg)
- \( X_3 \) = fertilizer (kg)
- \( X_4 \) = labour (HKO)

### 3. Results and Discussion

There are many differences in the use of input in Landscape IPM farming with non-IPM landscape farming. The number of seeds used in non-IPM landscape farming is greater than the seeds used by IPM landscape farming. This is led by the application of legowo cropping system by landscape IPM farming which can reduce the amount of seeds needed by farming. Meanwhile, the amount of fertilizer used by landscape IPM farming is greater than non-IPM landscape farming. Landscape IPM farming uses the concept of balanced fertilization where there is a comparison between the application of urea, phonska, and organic fertilizers where organic fertilizer is the largest amount of fertilizer among other fertilizers. Most of the IPM landscape farming does not use chemical pesticides at all, in contrast to non-IPM landscape farming that uses chemical pesticides that function to control plant hopper populations on agricultural land.

The first test is done to see whether there is a significant difference between the production of landscape IPM farming and non-IPM landscape farming. The results of the two mean tests can be seen in Table 1.

| Description | LIPM Adopters | Non LIPM Adopters |
|-------------|---------------|-------------------|
| Mean of productivity (ton/ha) | 6.44 | 5.54 |
| t-value | 0.339 | 0.736 |
| t-sig | 0.736 | 0.339 |
| Conclusion | No significant difference | |

Based on Table 1 it can be seen that the probability of t test is greater than alpha so that the conclusion that can be drawn is that there is no significant difference between the production of landscape IPM farming and non-IPM landscape farming. This information is a new consideration for farmers because even though landscape IPM farming has a higher average productivity than non-IPM landscape farming, the difference in both is insignificant. This proves that the application of landscape IPM to farmers in Pliken Village has not been optimal so it has not been able to significantly increase farm productivity. Some farmers who adopt landscape IPM still have farming production that is not much different or even the same as non-IPM landscape farming.

In addition to the independent t test, information that can provide an explanation of the production of rice farming in Pliken Village which can be seen from the scatter plot of the production of each sample. By observing it, we can see the distribution of production data and the difference between the
production of landscape IPM farming and non-IPM landscape farming. Latter, there will be a comparison of the coefficient of variation in LIPM farm and non LIPM farm. That comparisons between two variation coefficient values will be used to determine whether the application of landscape IPM to farmers can reduce the risk of farming production or not.

![Figure 1. Production of Pliken Village Rice Farming in 2015/2016.](image)

Samples of 1 to 30 are landscape IPM farming, while samples from 31 to 60 are non-adopters. Based on this picture, it can be seen that between landscape IPM farming and non-IPM landscape farming there is no significant difference. Even so, the average productivity of landscape IPM farming remains larger because there are samples that have production far above other samples so that this results in high average productivity. Therefore, the results of an independent t test that shows that there is no significant difference between the two is in accordance with the scatter plot of farm production.

However, it would be better if farmers who have not adopted landscape IPM can start implementing landscape IPM because if there are more and more landscape IPM participants, then the possibility of landscape IPM can have a better impact on the larger Pliken Village ecosystem. The good impact referred to is the avoidance of the environment from pollution due to chemical pesticides and the avoidance of farmers from the dangers of diseases that can result from inhaling chemical pesticides.

Production risk will greatly affect the production and productivity of farming. To find out the relationship between production risk and productivity can be seen in Table 2.

| Description               | Coefficient of Variation (CV) |
|---------------------------|-------------------------------|
| LIPM adopters             | 0.57                          |
| Non LIPM adopters         | 0.72                          |

Table 2 shows that landscape IPM farming has a smaller risk of production than non-IPM landscape farming. The smaller the risk of production owned by farming, the greater the productivity that can be produced. However, this can only be proven if we see the results of this study which only compares two types of rice farming. The results of the research conducted by Fauzziyah [7] and Mulyanti [8] showed that the smaller risks do not always show higher productivity.
After knowing the results of the independent sample t test and the coefficient of variation, then multiple linear regression was carried out using the production risk function model to determine the effect of farming inputs on the risk of production. Before the regression is carried out, the model needs to be tested with a classic assumption test which includes tests of normality, multicollinearity, and heterocedasticity. After the tests are carried out, the regression model is proven to be free of problems so that regression can be done on the model.

| Variables      | Production Function | Risk of Production Function |
|----------------|---------------------|-----------------------------|
|                | Coefficient | t-sig  | Coefficient | t-sig  |
| Constant       | 2.409       | 0.000  | -3.341      | 0.338  |
| Ln land (X1)   | 0.299***   | 0.008  | -0.356      | 0.583  |
| Ln Seed (X2)   | 0.603***   | 0.000  | 0.025       | 0.972  |
| Ln Urea (X3)   | 0.072       | 0.368  | 0.389       | 0.406  |
| Ln Tenaga Kerja (X4) | 0.112  | 0.283  | 0.137       | 0.823  |
| Dummy Refugia (Dref) | 0.030  | 0.782  | -0.518      | 0.441  |
| Dummy Pest (Dopt) | 0.101  | 0.357  | 2.091***    | 0.006  |

Based on Table 3 it can be seen that there are 2 variables that have a significant effect on farm production, namely land area and seeds. However, there is only one independent variable that significantly affects the risk of production. That variable is pest. Whereas other independent variables such as land area, seeds, urea fertilizer, labor, and interest in refugia do not significantly influence the amount of production risk.

Meanwhile, pests are herbivores that need cultivation plants to meet their food needs. OPT is one of the factors that significantly influence the risk of farming production. From the regression results of the risk function, it is known that pest has a positive effect on the risk of production. So it can be said that the production owned by farming that often experience pest disturbances is significantly different from the production of farming which rarely experience pest disturbances. The risk of farming production that often experiences higher pest disturbances than farming that rarely experiences pest disturbances.

The difference is related to pest control efforts conducted by farmers in Pliken Village. Based on the data obtained, it is known that as much as 26.67% of landscape IPM farming often experience pest disturbances while non-IPM landscapes that often experience OPT disturbances are 30%. This difference indicates that the percentage of non-IPM landscapes farming that often experience pest disturbance is greater than IPM landscape farming. Even so, a relatively small percentage difference indicates that pest control on landscape IPM farming is not optimal and still needs to be improved. This is supported by the results of the regression of production function and production risk which shows that there is no significant influence by refugia's interest on production and production risk.

4. Conclusion
Although landscape IPM farming has a smaller risk of production than non-IPM landscape farm, there are no significant differences between the production of landscape IPM and non LIPM farm. Furthermore, the factors that influence the risk of production are the presence of pests in the rice farming area of Pliken Village. This shows that the implementation of landscape IPM programs has not been able to have a significant impact on increasing land productivity. Therefore, it is recommended for farmers who have not adopted landscape IPM have begun to adopt in order to optimize the results obtained from the implementation of IPM landscapes.
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