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## JAJAR LEGOWO PLANTING SYSTEM AS THE STRATEGY ON CLIMATE CHANGE ADAPTATION (CASE STUDY IN SRIGADING VILLAGE, LAWANG DISTRICT, MALANG)

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**ABSTRACT:** Most Indonesian people need rice as their staple food. East Java is one of provinces in Indonesia which has large potential of rice farming productivity. One area in East Java Province which played role as central rice production is Lawang District. Moreover, Srigading Village, the location of this research, is one village in Lawang District that livelihood of the most people in the area is farmer. Farmers in Srigading Village often face crops failure because the field was affected by climate change. The purpose of this research is to analyze the application of jajar legowo planting system as an effort to increase farmer income and as the strategy to the climate change adaptation. Data type that used in this research is cross sectional data mostly generated using interview with the respondents. Data in this research was rice farming data in one planting season which is from February to June. T-test is applied to test the average result between jajar legowo planting system and conventional planting system. The results show that Jajar Legowo planting system has better performance, considering production and less cost applied, compared to the conventional planting system.

Keywords: paddy field, farming, jajar legowo, conventional, climate change

# INTRODUCTION

Rice is main commodity in Indonesia because its 248 million populations by 2014 mostly consume rice as the main staple food. Demand for rice as the main staple food has significant effect to increase productivity and preserve this commodity.

East Java Province is one province that played significant role in increasing rice production in Indonesia by 3.22%. East Java province produces 12,043,924 tons rice in 2012 or approximately 17.47% from total national production (CBS, 2012). One of districts in East Java which becomes central food crops production, especially rice is Lawang District, Malang Regency. Based on data from Department of Agriculture, number of rice production in Lawang District by 2013 was 13,848 tons.

Srigading Village is one of villages in Lawang District, in which most people in that village are farmers. Most of commodities which cultivated in Lawang are rice and corn. Wetland characteristic in Srigading Village categorized as rainfed areas, which the water source comes from the rainfall. Climate change phenomenon, which can be seen from global warming effect, such as temperature increase and uneven rainfall distribution, results in problems for rainfed wetland areas. Therefore, most farmers in Srigading Village always suffer from crop failure.

The change of planting system from conventional to jajar legowo – which made by some members of Aman Makmur Farmer Group in Srigading Village – aims to decrease crop failure as the system based on early research had proved the increase of yield production, decrease fertilizer and water usage. Theoreticaly, the farmers’ income will increase along with yield production. Farming process which minimizes the use of chemical fertilizer and water usage can be a better choice as adaptation strategy towards climate change.

Based on problem formulation above, the objectives of this research as follow: 1) To describe rice farming which applied jajar legowo planting system as the strategy on climate change adaption compared to non-jajar legowo planting system in the research area; 2) To analyze the level of cost between jajar legowo and conventional rice farming system in the research area; and 3) To analyze the level of rice farming income ratio between jajar legowo planting system and conventional rice farming in the research area.

# RESEARCH METHOD

Research location was selected purposively (intentionally) in Srigading Village, because it had farmer group who actively participates in the Climate Field School (SLI) and already implemented some strategies such as climate change adaptation.

This study used primary data which obtained from interview with Aman Makmur Farmer Groups and secondary data which obtained from Department of Agriculture, Central Bureau of Statistics (BPS) and Meteorology, Climatology and Geophysics Agency (BMKG). In addition, data also obtained from other sources such as books, journals, articles and several related agencies.

In accordance with the objectives set in this study, we used three methods of data analysis as follow:

Objective 1: to describe the application of jajar legowo and conventional rice farming system

This objective was analyzed using descriptive qualitative analysis method in order to describe the implementation of jajar legowo and conventional rice farming system in the research area. Based on literature study, Arikunto (2002) stated that a qualitative descriptive analysis is an analysis that describes situation in the field by using sentences or words to describe situation, phenomenon and the fact in field scientifically. It is normal situation without any manipulation.

Objective 2: to analyze the level of revenue and cost between jajar legowo and conventional rice farming system

This objective is measured by farming analysis as follows:

A. Rice Farming Income:

TR = Y. Py

Where:

TR = Total revenue for jajar legowo and conventional rice farming

Y = Yield (Kg) for jajar legowo and conventional rice farming

Py = Price (Rp) for jajar legowo and conventional rice farming

B. Rice farming production cost

TC = FC + VC

Where:

TC = Total cost (Rp) for jajar legowo and conventional rice farming

FC = Fixed cost (Rp) for jajar legowo and conventional rice farming

VC = Variable cost (Rp) for jajar legowo and conventional rice farming

Objective 3: to compare the level of income for jajar legowo and conventional system

This objective was analyzed using rice farming income analysis and analysis of different average test of T-test. Formulation for rice farming income analysis as follows:

$$π=TR-TC$$

Where:

$π$ = Income of jajar legowo and conventional rice farming

TR = Total revenue of jajar legowo and conventional rice farming

TC = Total cost of jajar legowo and conventional rice farming

Statistical hypothesis determination as follows:

H0 : µ1 = µ2

H1 : µ1 ≠ µ2

Where:

µ1 = Average prodoction of jajar legowo rice farming

µ2 = Average production of conventional rice farming

After obtaining the income level from each cropping system, both then compared using average difference test (t-test) with the following steps:

Variance or variety test (S2) of both groups whether or not to do the same variant of the formula:

S12 = $\frac{Σ (xi-\overbar{X}\_{1})^{2}}{(n\_{1}-1)}$ S22 = $\frac{Σ (xi-\overbar{X}\_{2})^{2}}{(n\_{2}-1)}$

Where:

Xi = Jajar legowo rice farming production (i = 1 to 12)

Xj = Conventional rice farming production (j = 1 to 25)

$\overbar{X}$1 = Average production of jajar legowo rice farming (i = 1 to 12)

$\overbar{X}$2 = Average production of conventional rice farming (j = 1 to 25)

n1 = Number of farmer samples on jajar legowo rice farming

n2 = Number of farmer samples on conventional rice farming

To know the difference between S12 and S22, further F test would be applied with the formula as follows:

F count = $\frac{S\_{1}^{2}}{S\_{2}^{2}}$

Where:

S12 = Production variable of jajar legowo rice farming

S22 = Production variable of conventional rice farming

**RESULTS AND DISCUSSION**

**The Implementation of Jajar Legowo Planting System and Conventional Rice Farming System as Climate Change Adaptation**

Based on observations and interview that conducted by the researcher, it was found that since 2011 farmers from Aman Makmur Farmer Group received study about the climate. This study called Climate Field School (SLI) and conducted as an effort to minimize losses and failures in farming. In SLI, farmers can improve their ability to anticipate the impact of climate change, translating the results of climate forecasting to support farming activities and minimize the negative impact of drought, flood and pest damage. Data of Srigading Village area that suffered by drought, flood and also affected by pest can be seen in the picture below.



Figure 1. Percentage of drought land, flooded land as well as pest damages in Srigading village

 Overall, rice field area which located in Srigading Village is 39 ha. In 2012, 37 hectares (ha) or 94.8% rainfed area in Srigading Village affected by drought, so that farmers suffered by financial loss and crop failure. In 2013, in rainy season, the rainfed areas suffered by flood for about 35 ha or 89.74% from total 39 ha land area. As a result of flooded land, rice plants could not grow optimally, in which it caused financial loss. In 2012 farmers in Srigading Village suffered from great financial loss due to rice crop damage that caused by pests. In the diagram above, it could be seen that the greatest damage to rice crops caused by stem borers for 51% or 25 ha. Other pest was Xanthomonas oryzae or bacteria that caused blight and created damage for 21% or 16 ha. For 15 ha or 20% rice field also damage which caused by rats. Other cause of damage was grasshopper that created relatively low damage for 8% or 10 ha.

 Farmer activities at SLI in the end of 2013 resulted several decisions, one of them was the change of cropping system from tegel to jajar legowo 2: 1 as an effort to increase revenue and minimize losses due to drought. In 2014, a number of farmers who apply jajar legowo planting system were only 12 farmers. Setyaningtyas (2016) in her research explained that jajar legowo planting system has multiple benefits, one of the benefits is to apply water-saving. Water saving can be applied because jajar legowo planting system has groove hallway that will facilitate water flow evenly to all overlays. This research result proved that jajar legowo planting system was appropriate to be applied by farmers in Srigading Village which has rather wet climate type.

 In addition to fluctuated conditions of rainfall and climate type, other condition which became selection factor for the use of jajar legowo planting system was global warming caused by greenhouse gas emissions (GHG). It was explained that agricultural activities such as tilling, watering and fertilizing are human activity that mostly increase GHG emissions. Jajar legowo planting system was an appropriate planting system to be applied as an effort to reduce GHG emissions and increase farmer’s income. Pangerang (2013), in his study mentioned that one of the advantages of jajar legowo planting system is the increase of optimum sunlight intensity that plant can receive. According to Salisbury and Ross (1995), high solar radiation will increase the level of carotenoid, nitrogen content and affect anatomical structure of leaves. The increase of carotenoid level and nitrogen content results in reducing the use of chemical fertilizers. Thus, the level of GHG emissions that resulted from fertilization activity also can be reduced.

 Jajar legowo planting method that applied in the study area was legowo type 2: 1. In jajar legowo planting system 2: 1, every 2 rows of rice plants there will be interspersed by one blank row as the hallway, in which its width is two folds distance between rows so that the space of intersperse is 50 cm. Spacing in legowo type 2: 1 made as 25 cm (distance between rows) x 15 cm (distance in rows) x 50 cm (distance hall). Whereas, in conventional farming, cropping system adopt tile system that hass pacing of 25 cm (distance between rows) x 25 cm (distance in rows) without hall which intersperses group planting rows.

**Cost Comparison Analysis of Conventional and Jajar Legowo Planting System in the Research Area**

Table 1. Average Cost Per Hectare of Jajar Legowo and Conventional Rice Productivity in Srigading Village (njajar legowo = 12, nconventional = 25)

|  |  |  |  |
| --- | --- | --- | --- |
| No | Variable | Jajar Legowo (Rp/ha) | Conventional (Rp/ha) |
| 1. | Fixed Cost | 1.064.778 | 1.269.247 |
| 2. | Variable Cost | 8.457.050 | 11.285.770 |
| Total Cost | 9.521.828 | 12.555.017 |

Results of production cost analysis to the jajar legowo and conventional rice farming system i presented in Table 1.

 Table 1 is summary of cash flow table contained in the attachment. In Table 1 it could be seen that total cost which required by 25 farmers in conventional rice farming was much greater than the total cost of 12 farmers who apply jajar legowo planting system. Melasari (2011) in his research revealed that technical implementation of jajar legowo farming requires less input than conventional farming, such as the needs of seed, fertilizer and labor. Fertilizer needs for jajar legowo planting system was less than conventional cropping systems. This was due to rice plant in jajar legowo planting system obtained more sunlight intensity compared to conventional cropping systems. High solar radiation will increase nitrogen content so that plants do not require much additional nitrogen supply from chemical fertilizers. This difference was scientifically proven through statistical analysis. The statistical data showed t-value 94.095 with greater significance at α 0.01 and t-table 2.624 at 95% confidence level.

**Income Analysis of Jajar Legowo and Conventional Rice Farming**

The result of comparison income between jajar legowo and conventional rice farming presented in Table 2.

Table 2. Average income for jajar legowo and conventional rice farming in Srigading Village (njajar legowofarmer = 12, nconventional farmer = 25)

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Variable | Jajar Legowo | Conventional |
| 1. | The Amount of Productivity (kg/ha) | 7.568 | 5.835 |
| 2. | Selling price (Rp/kg) | 4.400 | 4.400 |
| Revenue | 33.299.933 | 28.659.077 |
| 3. | Fixed cost (Rp/ha) | 1.064.778 | 1.269.247 |
| 4. | Variable Cost (Rp/ha) | 8.457.050 | 11.285.770 |
| Income (Rp/ha) | 23.778.106 | 16.104.061 |

Table 2 above showed that the average income per hectare for jajar legowo rice farmer was higher than conventional rice farmer. The income difference occurred because production cost for jajar legowo planting system was lower than conventional cropping systems. It was in line with the amount of production for jajar legowo planting system that was higher than the conventional cropping systems. This difference was statistically significant where t-value 18.736 was greater than t-table 2.650 at 99%confidence level. From a research that conducted by Misran (2014), it was concluded that jajar legowo planting system significantly affects yield components especially at panicle length, number of grains per panicle and grain yield. The production of ciherang rice using jajar legowo planting system resulted in more farmers gained greater acceptance as compared to conventional system. It directly affected the increase of farmer’s income. As what showed in the table above, the average income of Legowo rice farmers was Rp23.778.106 per hectare, whereas conventional rice farmers was Rp16.104.061. The second difference was Rp7.674.045 revenue using 99% confidence level.

**CONCLUSION AND SUGGESTION**

**Conclusion**

Based on analysis result that conducted in this study, it could be concluded as follows:

1. Based on the research that had been conducted in Srigading Village, Lawang District, Malang Regency, it could be concluded that jajar legowo planting system was applied by members of Aman Makmur Farmer Group which participated in climate field school using legowo type 2: 1. Jajar legowo planting system was selected as a strategy for climate change adaptation because it has multiple benefits; one of them was water-saving benefit.

2. In addition, jajar legowo planting system had been proven to reduce greenhouse gas emissions (GHG) caused by fertilization activity. This might occur due to one of the advantages from jajar legowo planting system, which was the increase of optimum sunlight intensity that plants receive. High solar radiation will increase level of carotenoids, nitrogen content and affects anatomical structure of leaves. The increase of carotenoid level and the nitrogen content resulted in reducing the use of chemical fertilizers. Thus, level of GHG emissions resulted from fertilization activity also could be reduced

3. The result of statistical and farming analysis with average difference test proved that the average amount of jajar legowo rice farming production was higher than conventional rice farming. While the average farm cost of non-jajar legowo (conventional) rice farmers was greater than jajar legowo. Jajar legowo farming used fertilizer more efficiently, because it needed less fertilizer compared to conventional farming.

4. Revenue analysis per hectare on jajar legowo rice farming showed higher yield than conventional one. The revenue of jajar legowo planting system gained greater yield because the amount of production was greater than conventional cropping systems. Beside cost of jajar legowo farmers that less than conventional farmers, similarly, statistical conclusions from different test average showed the same conclusion.

**Sugestions**

Based on the analysis result, some advices that can be given regarding the research results as follow:

1. In order to increase farmer’s income, jajar legowo rice farming is better alternative than conventional farming system; therefore, it is encouraging to apply extensively this method in order to increase the profit of farming.
2. In order to assure the farmers related to the benefits and advantages of jajar legowo planting system, it needs more efforts from extention officer and higher education of Agriculture Faculty. Local group of farmers plays important role in desiminating this technology.

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