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Analysis of Organic and Conventional Lowland Rice (*oryza sativa l*) Cultivation Systems in Supporting Environmentally Friendly Agriculture in Beringin District, Deli Serdang Regency

Ichpan Zulfansyah*[*1], Nini Rahmawai[2], Delvian[3]

*[*1]Natural Resources and Environmental Management Study Program, Postgraduate School, Universitas Sumatera Utara, Medan, 20155, Indonesia*
[2]Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, 20155, Indonesia
[3]Faculty of Forestry, Universitas Sumatera Utara, Medan, 20155, Indonesia

Abstract. *The application of organic agriculture in lowland rice farming is one of the interesting topics in an effort to reduce environmental pollution caused by the use of chemical fertilizers and pesticides. This study aimed to determine the level of production and analyze the environmental impact of the soil from the application of organic and conventional agriculture in the Banyan District, Deli Serdang Regency. The results showed that 1) There was a significant difference between the production of harvested dry grain (GKP) of organic paddy and the production of harvested dry grain (GKP) of conventional lowland rice. 2) The level of soil fertility in organic and conventional lowland rice farming has low criteria*

Keywords: *Conventional lowland rice, Dry grain, Environmentally friendly agriculture, Organic lowland rice farming, Oryza sativa.*

Abstrak. Penerapan pertanian organik pada usahatani padi sawah merupakan salah satu topik yang menarik dalam upaya mengurangi pencemaran lingkungan akibat penggunaan pupuk dan pestisida kimia. Penelitian ini bertujuan untuk mengetahui tingkat produksi dan menganalisis dampak lingkungan tanah dari penerapan pertanian organik dan konvensional di Kecamatan Banyan Kabupaten Deli Serdang. Hasil penelitian menunjukkan bahwa 1) Ada perbedaan yang signifikan antara produksi gabah kering panen (GKP) padi organik dengan produksi gabah kering panen (GKP) padi sawah konvensional. 2) Tingkat kesuburan tanah pada usahatani padi sawah organik dan konvensional memiliki kriteria rendah

Kata Kunci: Gabah kering, Oryza sativa, Pertanian ramah lingkungan, Sawah konvensional, Sawah organik.

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1. Introduction

The implementation of lowland rice farming by farmers in Indonesia still used chemical fertilizers as a source of nutrition for plants. This has been going on continuously until now. The relatively high and continuous use of chemical fertilizers has a significant impact on the growth and high yields of lowland rice plants. On the other hand, the use of chemical fertilizers which are carried

*Corresponding author at: Postgraduate School, Universitas Sumatera Utara, Jalan Prof. Mass, Medan 20155, Indonesia

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out for years can have a negative impact on the soil environment, thereby reducing the productivity of agricultural land.

The used of chemical fertilizers intended to supplement soil nutrients for plants has actually polluted the environment, either directly or indirectly. The high level of plant productivity with the presence of superior seeds, the fertility of plants due to the use of chemical fertilizers, and the elimination of plant pests because the efficacy of chemical pesticides has put humans as the winner in fighting nature. Humans become less wise and become hostile to nature and the environment. The nature where humans live has been forgotten and its sustainability neglected by human carelessness and greed. As a result of this exploitation, nature then loses its balance which ultimately has a negative impact on humans and the long-term pesticide residues in the food consumed daily can cause health problems which can be indicated by the presence of acute symptoms (headache, nausea, vomit, etc) and chronic symptoms (loss of appetite, tremors, muscle spasms, etc.). [1]

This condition raised the idea to re-implement organic farming. Organic agriculture as an agricultural production system based on the principle of biological recycling. Recycling of nutrients can be done through plant and livestock waste, as well as other plants that can improve fertility status and soil structure. [2]

So far, farmers think that organic fertilizers and pesticides are seen as some problems and require more power to manage and use them. Farmers still have concerns that they will experience difficulties in obtaining fertilizers and pesticides from organic ingredients. Farmers have not been able to see the local potential in the form of agricultural waste and manure which is abundantly available which can be managed into organic fertilizer. Likewise, various plants that can be used as organic pesticides are no longer widely used due to limited knowledge of farmers. The awareness was to manage the environment for the better is often overpowered by considerations of technical convenience. [3]

Seeing from the long-term contribution of organic lowland rice farming, it gave hope for environmental sustainability because the maintenance of good soil ecosystems and nutrients that are always available for lowland rice plants. Sustainable organic agriculture also has an important role in crop productivity so that it continues to increase the growth and production of lowland rice plants.

2. Method

2.1 Research Description

This research was conducted from September 2019 to May 2020 in Karang Anyar Village, Beringin District, Deli Serdang Regency, Sumatera Utara. Correspondents in this study are members of the Mekar Pasar Kawat farmer group, Karanganyar Village, Deli Serdang Regency who applies organic and conventional lowland rice farming.

2.2 Type and Source of Data

In this study, there are two types of data, namely primary and secondary data. Primary data is data obtained from observations and direct sampling at the research location, results of laboratory test analysis, and also results of direct interview with farmers using a list of questions (questionnaire). Primary data consists of data on yields of harvested dry grain (GKP), soil pH, nitrogen (N), phosphor (P), potassium (K), and soil cation exchange capacity (KTK). Secondary data is data obtained from the data from the Mekar Pasar Kawat farmer group report, the village head office data, the Deli Serdang agriculture department and other agencies that are still related to this research. Secondary data consists of the area of agricultural land, crop conditions, organizational structure and SOP (Standard Operational Procedure) of farmer groups.

2.3 Sampling Method

Determination and sampling in this study using purposive sampling method (deliberate sampling with a specific purpose) and proportional stratified random sampling (balanced stratified random sampling). There are two types of samples used in this study it namely soil samples from organic and conventional lowland rice farming and 10 organic lowland rice farmers in the transition year of 2010 and 10 conventional lowland rice farmers.

2.4 Data Analysis

The data analysis method used in this study is the analysis method of the two-party average difference test (T-test) with the formula :

$$t-hitung = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$$

$$S_1^2 = \frac{n.\sum X_1^2 - \left(\sum X_1\right)^2}{n(n-1)} \qquad S_2^2 = \frac{n.\sum X_1^2 - \left(\sum X_2\right)^2}{n(n-1)}$$

Where, X1 is average production variable or income of organic farmers, X2 is average production variable of conventional farmer, S1 is standard deviation of the variable X1, S2 is standard deviation of the variable X2, n1 is number of samples X1, n2 is number of samples X2. Hypothesis testing criteria using formula:

H_0 is accepted if : W1 t1 + t2 < t – count < W1t1

+ W2t2W1 + W2 W1

+ W2

H_1 is accepted if : W1 t1 + t2 > t – count > W1t1

+ W2t2W1 + W2 W1

+ W2

With :

$W1_1 = S_1^2/n$; $W2_2 = S_2^2/n$

t1 = t (1 - ½ α), (n1 - 1)

t2 = t (1 - ½ α), (n2 - 1)

at the 95% confidence or α = 0,05

3. Results and Discussion

3.1 Analysis of the Initial Soil Fertility (Pre-planting Planting Season I) of Organic and Conventional Lowland Rice in 2019

The results of the analysis of initial soil fertility levels (pre-planting planting season I in 2019) organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming in Beringin District, Deli Serdang Regency are presented in table 1 below.

Tabel 1. The results of the analysis of the initial soil fertility (pre-planting season I in 2019) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming

No	Nature of soil	Organic lowland rice farming in the transition year of 2010	Conventional lowlandrice farming
1	pH (H_2O)	5,6	5,5
2	Nitrogen (%)	0,15	0,09
3	Phosphor (P_2O_5 - Bray)	25,9	40,6
4	Potassium (me/100g)	0,43	0,18
5	KTK (me/100g)	6,02	4,54

Based on the results of the analysis soil laboratory analysis (pre-planting planting season I) in 2019 (table 1), the soil pH at the researched location has a slightly acid to acidic criteria [4]. Organic lowland rice farming in the transition year 2010 has a pH level of 5.6 and conventional lowland rice farming has a pH level of 5.5. Soil nitrogen (N) content in the research location has very low to low criteria [4].

Organic lowland rice farming in the transitional year 2010 had a nitrogen (N) content of 0.15% and conventional lowland rice farming had a nitrogen (N) content of 0.09%. Soil phosphor (P) content in this location study has high to very high criteria [4]. Organic lowland rice farming in the transition year of 2010 has a phosphor (P) content of 25.9 ppm and conventional lowland rice farming has a phosphorus content (P) of 40.6 ppm. The potassium (K) content of the soil in the study location had low to moderate criteria [4]. Organic lowland rice farming in the transition year of 2010 has a potassium (K) content of 0.43 me/100gr and conventional lowland rice farming has a potassium (K) content of 0.18 me/100gr. The value of the soil cation exchange capacity (KTK) at researched location had a low to very low criteria [4]. Organic lowland rice farming in the transitional year of 2010 had a soil cation exchange capacity (KTK) of 6.02 me/100gr and conventional lowland rice farming had a soil cation exchange capacity (KTK) of 4.54 me/100gr.

3.2 Analysis of final soil fertility (post-harvest season II in 2019) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming

The results of the analysis of soil fertility levels at the beginning of the end (post-harvest planting season II in 2019) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming in Beringin District Deli Serdang Regency are presented in table 2

Table 2. The results of the analysis of the final soil fertility level (post-harvest planting season II in 2019) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming

No	Nature of soil	Organic lowland rice farming transition year of 2010	Conventional lowland rice farming
1	pH (H_2O)	5,7	5,4
2	Nitrogen (%)	0,10	0,08
3	Phosphor (P_2O_5 - Bray)	29,87	38,73
4	Potassium (me/100g)	0,26	0,15
5	KTK (me/100g)	6,17	4,97

3.2.1 Soil pH

Based on the results of the final soil laboratory analysis (post-harvest planting season II in 2019) (table 2), Organic lowland rice farming in the transition year of 2010 has soil pH with slightly acidic criteria [4] with a pH value of 5.7. The soil pH value has increased by 1.78% from the initial soil pH (pre-planting in planting season I in 2019). Conventional lowland rice farming has soil pH with acid criteria [4] with a pH level of 5.4. The soil pH value has decreased by 1.81% from the initial soil pH (pre-planting planting season I in 2019). The increase and decrease in pH value of organic lowland rice farming in 2010 and conventional rice fields is presented in Figure 1.

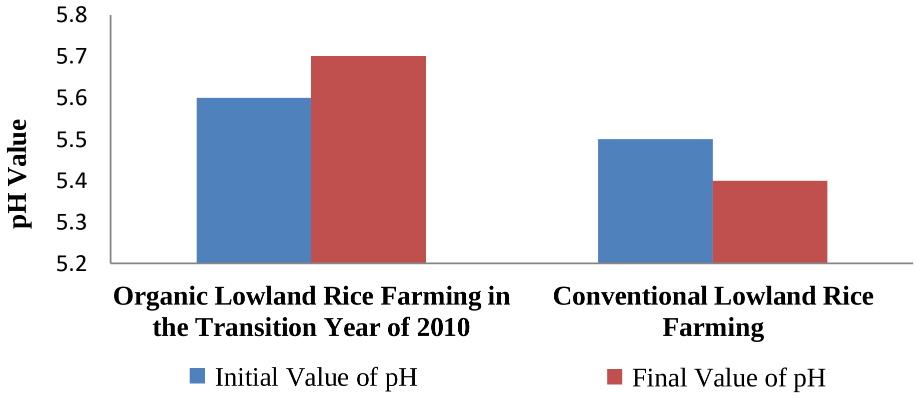

Figure 1. Increase and decrease in final soil pH value (post-harvest planting season II in 2019) organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming.

The increase in soil pH that occurred in organic lowland rice farming in the transition year of 2010 was caused by the activity of adding organic matter in the form of manure during the agricultural land processing process [5]. The decrease in soil pH value that occurs in conventional lowland rice farming is thought to be due to the addition of nitrogen (N) through the use of ZA fertilizers by conventional farmers, the use of ZA fertilizers to add nitrogen (N) can actually acidify the soil [6].

3.2.2 Cation Exchange Capacity (KTK)

Based on the results of the final soil laboratory analysis (post-harvest planting season II in 2019) (table 2), organic lowland rice farming in the transitional year of 2010 has a low soil cation exchange capacity (KTK) value [4] with a land cation exchange capacity (KTK) of 6.17 me/100gr. The land cation exchange capacity (KTK) value has increased by 2.49% from the initial soil cation exchange capacity (KTK) value (pre-planting planting season I in 2019). Conventional lowland rice farming has a cation exchange capacity (KTK) with very low criteria [4] with a cation exchange capacity (KTK) of 4.97 me/100gr. The land cation exchange capacity (KTK) value has decreased by 16.66% from the initial soil cation exchange capacity (KTK) value (pre-planting planting season I in 2019). Decrease in the value of cation exchange capacity (KTK) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming are presented in Figure 2.

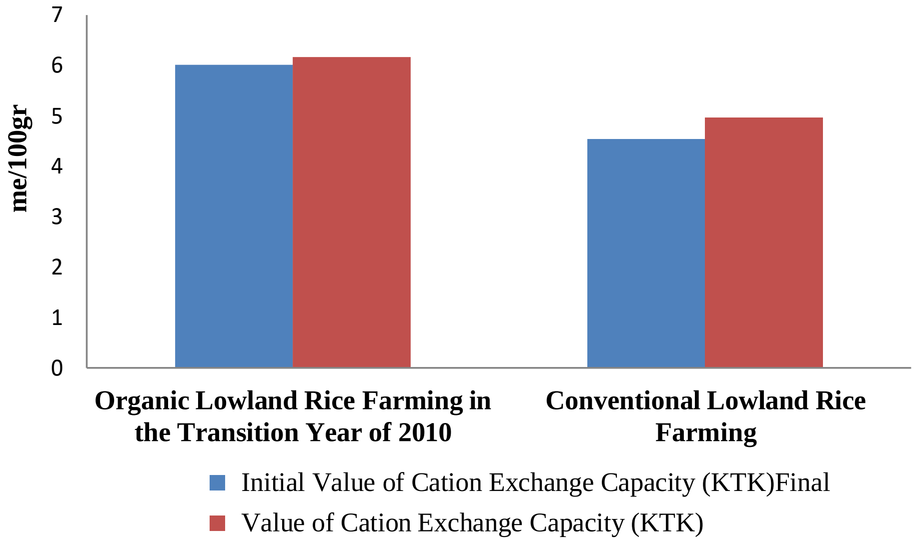

Figure 2. Increased cation exchange capacity (KTK) of final soil (post-harvest planting season II in 2019) organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming.

The increase in cation exchange capacity (KTK) in organic lowland rice farming in the transition year of 2010 is due to the effect of the addition of organic matter which is given as fertilizer. The addition of organic fertilizers gives a negative charge reaction in the soil. The negative charge comes from the carboxyl (COO-) and hydroxyl (OH-) groups contained by organic matter. Dissociation of carboxyl and hydroxyl groups of organic compounds can increase the negative charge in the soil [7]. The increase in the value of KTK due to the provision of organic matter can increase the availability of nutrients needed by plants. In conventional lowland rice farming, an increase in KTK has also occurred but has not been able to keep up with the value of KTK of organic lowland rice farming. This was because in the farming process conventional rice farmers use chemical fertilizers as basic fertilizers so that the availability of organic matter is limited. About 20 - 70% of the soil cation exchange capacity is generally sourced from humus colloids, so there is a correlation between organic matter and soil KTK. Organic matter greatly affects the size of KTK and becomes a source of energy for microorganisms [8].

3.2.3 Nitrogen (N)

Based on the results of the final soil laboratory analysis (post-harvest planting season II in 2019) (table 2), organic lowland rice farming in the transition year of 2010 had low nitrogen (N) content [4] with a nitrogen (N) content of 0.10%. The soil nitrogen (N) content has decreased by 33.33% from the initial soil nitrogen (N) content (pre-planting planting season I in 2019). Conventional lowland rice farming has nitrogen (N) content with very low criteria [4] with a nitrogen (N) content of 0.08%. The soil nitrogen (N) content has decreased by 11.11% from the initial soil nitrogen (N) content (pre-planting planting season I in 2019). The reduction in nitrogen (N) content of organic lowland rice farming in 2010 and conventional rice fields is presented in Figure 3.

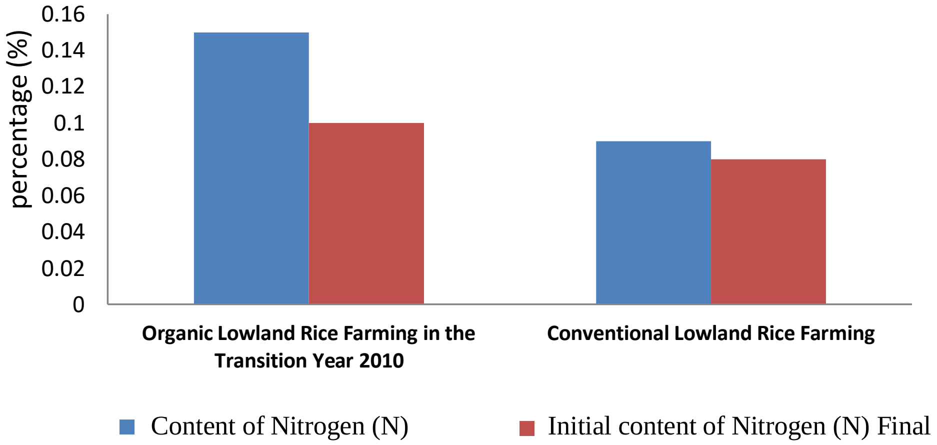

Figure 3. Decrease in nitrogen (N) content of final soil (post-harvest MT II in 2019) organic lowland rice farming in transition year of 2010 and conventional lowland rice farming

The reduction in soil nitrogen (N) content that occurs in organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming is due to absorption by the plants themselves and also due to the nature of nitrogen (N) which is very mobile so it is easily lost due to leaching. The loss of nitrogen in the form of NO3 is because it is easily washed by rainwater (leaching) and cannot be handled by soil colloids, especially in soils with low KTK values [9]. These results are supported by the results of other studies which state that in general the fertility of rice fields is relatively diverse, loss of nitrogen (N) is due to absorption by plants, transport to harvest and leaching by rainwater [10].

3.2.4. Phosphor (P)

Based on the results of the final soil laboratory analysis (post-harvest planting season II in 2019) (table 2), Organic lowland rice farming in the transition year of 2010 has a high content of phosphor (P) [4] with a phosphor (P) content of 29.87 ppm. The soil phosphor (P) content has decreased by 15.32% from the initial soil phosphor (P) content (pre-planting planting season I in 2019). Conventional lowland rice farming has a very high phosphor content (P) [4] with a phosphor (P) content of 38.73 ppm. The phosphor (P) content of the soil has decreased by 4.60% from the original soil phosphor (P) content (pre-planting planted season I in 2019). The increase and decrease in phosphor content (P) of organic lowland rice agricultural land in 2010 and conventional rice fields is presented in Figure 4.

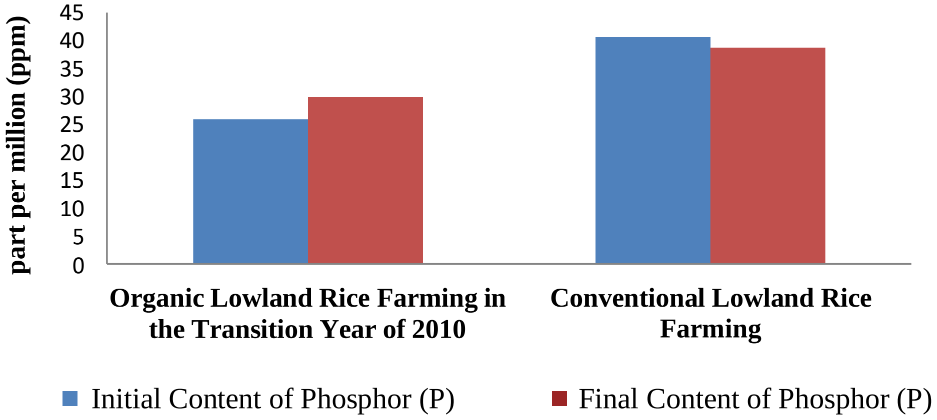

Figure 4. Increase and decrease in soil phosphor (P) content of final (post-harvest planting season in 2019) organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming

The increase and decrease in soil phosphor (P) content that occurred in organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming was strongly suspected to be closely related to the increase and decrease in soil pH at the beginning until the end. In most soils, the maximum availability of phosphor (P) is in the pH range between 6 - 7. The availability of phosphor (P) will decrease when the soil pH is lower than 6.0 or higher than 7 [11]. The phosphor (P) content of the final soil, which is still in the high to very high criteria, illustrates that the phosphor (P) requirement for rice plants grown in these fields does not require external input anymore. Phosphor (P) in the soil is classified as slow moving and generally can only take place through root interception and diffusion mechanisms over a short distance. As a result, only about 10-15% of phosphor is available in the soil and can be absorbed by plants [12].

3.2.5 Potassium (K)

Based on the results of the final soil laboratory analysis (post-harvest planting season II in 2019) (table 2), Organic lowland rice farming in the transition year of 2010 has a low content of potassium (K) [4] with a potassium (K) content of 0.26 me/100gr. The potassium (K) content of the soil has decreased by 39.53% of the initial soil potassium (K) content (pre-planting planting season I in 2019). Conventional lowland rice farming has low levels of potassium (K) [4] with potassium (K) content of 0.15 me/100gr. The potassium (K) content of the soil has decreased by 16.66% from the initial soil potassium (K) content (pre-planting planting season I in 2019). The reduction in potassium (K) content of organic lowland rice agricultural land in 2010 and conventional rice fields is presented in Figure 5.

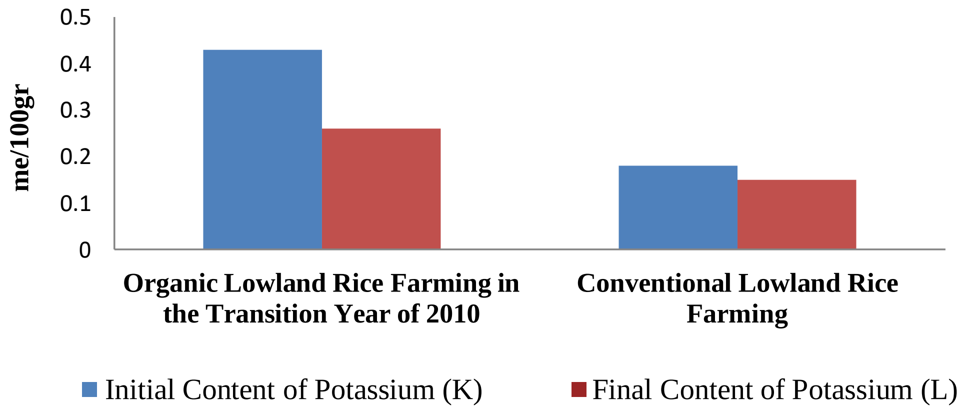

Figure 5. Decrease in potassium (K) content of final soil (post-harvest MT II in 2019) organic lowland rice farming in the transitional year of 2010 and conventional lowland rice farming

The decrease in potassium (K) content that occurred in organic lowland rice farming in the transition year of 2010 and conventional was thought to be absorbed by plants and plant needs were still higher than the availability of potassium (K) from soil and fertilizers. Nearly 80% of the potassium (K) absorbed by rice plants is in the straw [13]. So it is recommended to return the straw to the paddy soil as a source of soil potassium (K) after the rice is harvested [13]. In addition, the decrease in potassium (K) content is also due to the potassium nutrient in the soil which is easy to wash and the level of its content is strongly influenced by pH and the value of KTK. At low pH (acid) and low KTK, potassium is easily washed away [11].

3.3 Analysis of different test of harvested dry grain production (GKP) in organic lowland rice farming in the transitional year of 2010 and conventional lowland rice farming in planting season 2019

The results of the different test results of harvested dry grain (GKP) obtained by organic rice farmers in the transition year of 2010 and conventional lowland rice farming can be seen in the following table 3 :

Table 3. The results of average difference test of Harvested Dry Grain (GKP) Organic Lowland Rice Farming in the Transition Year of 2010 and Conventional Lowland Rice Farming in Planting Season 2019

Planting Season in 2019	GKP Production of Organic Lowland Rice Farming in the Transition Year of 2010 (Kg)	GKP Production of Conventional Lowland Rice Farming (Kg)	Results of the Significance of the Mean Difference Test (Test - t)	Information
I	898,65	782,97	51,99	Significant
II	862,59	742,89	33.17	Significant

Based on the results of the average difference test on the yield of harvested dry grain (GKP) of organic and conventional lowland rice (table 3), it shows that there is a significant difference between the production of harvested dry garin (GKP) of organic lowland rice farming in the transition year of 2010 and the production of harvested dry grain (GKP) conventional lowland rice farming at the 95% confidence level.

This is based on the results of the average different test results of harvested dry grain (GKP) of organic lowland rice in the transition year of 2010 which has a t stat value (51.99) in the first planting season and t stat (33.17) in the second season of planting in 2019 where both t stat value is greater than the two-tail Critical t value (2.26). The difference in the production of harvested dry grain (GKP) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming are presented in Figure 6.

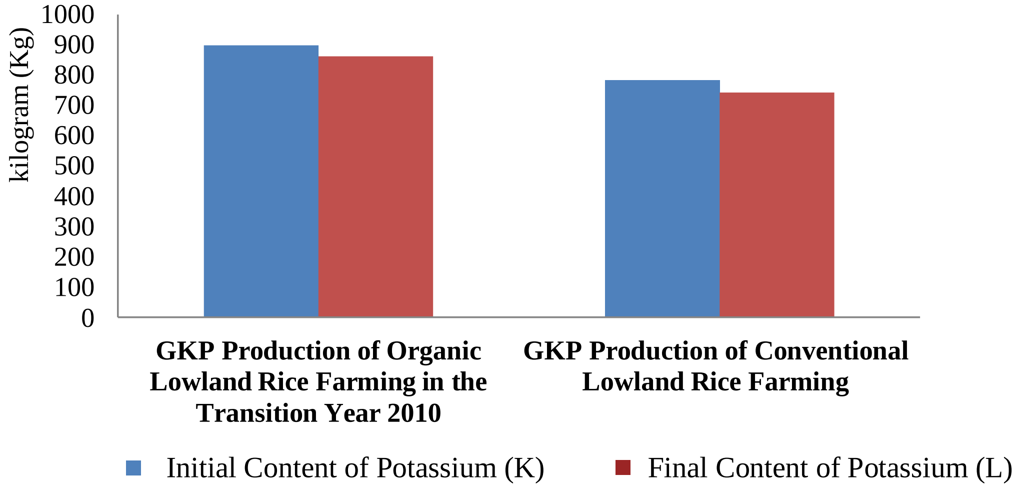

Figure 6. Differences in the production of harvested dry grain (GKP) of organic lowland rice farming in the transition year of 2010 and conventional lowland rice farming in the 2019 planting season

The higher production of harvested dry grain (GKP) rice of organic lowland rice farming in the transition year of 2010 when compared to conventional lowland rice farming production is thought to be due to the level of soil fertility itself. The source of organic agricultural nutrients is obtained from natural organic materials such as compost. Compost contains macro nutrients such as N, P, and K and micro nutrients such as Mn, Fe and Zn. The use of compost can physically increase soil porosity, biologically it can increase the activity of organisms so that the process of changing organic matter occurs more quickly [14]. These results are supported by the results of other study which found that the yield of organic rice using manure in the Sambirejo district during the planting season II in 2003/2004 was 5.6 tons/ha, while the yield of inorganic rice in the district was only 4.0 ton/ha [15].

The used of organic materials as a source of nutrients also improves the quality of agricultural soil with an organic system and can continue to increase along with the continuous application of organic agriculture. Nitrogen and phosphorus elements that are needed by plants in the vegetative phase are quite a lot contained in chicken manure. This condition also has an impact on plant height growth, maximum number of tillers and productive tillers that require nutrients, especially N and P. Pospor serves to stimulate growth and the formation of tillers or shoots in rice plants [16]. One of the functions of nitrogen absorbed by plants is to help plant vegetative growth [17].

The used of materials that are still natural (organic) in the application of organic agriculture actually provides an opportunity for decomposing microorganisms in the soil to grow optimally. Organic material is able to function as a source of energy and food for soil microorganisms in the process of overhauling organic matter [18]. Along with the overhaul of organic matter carried out by microorganisms, there will be a release of nutrients such as N, P and K needed by plants [19].

Its differents to the source of organic agricultural nutrients, the source of conventional agricultural nutrients comes from artificial chemicals. The used of chemicals that are continuously used in a land has a negative impact, such as making soil particles tightly bonded so that the soil can become very hard. This has an impact on plant roots which will be difficult to penetrate to carry out the nutrient absorption process. The land conditions of rice-producing countries, including Indonesia, are identified as experiencing deterioration in soil fertility or what is known as soil sickness [20]. The cause of soil sickness is poor land management. The results of other studied also state that Indonesia's land and water resources are experiencing deterioration in quality due to the excessive use of chemical fertilizers. The accumulation of chemical fertilizers results in a lot of toxic content due to the acidic pH of the soil, so that the diversity of soil microbes is very little. Thus the process of decomposition of organic matter does not go well [21].

4. Conclusion

Based on the study results it can be concluded that :

1. The production rate of Harvested Dry Grain (GKP) of organic lowland rice farming in transition year 2010 was higher than the production rate of Harvested Dry Grain (GKP) of conventional lowland rice farming.
2. In general, the soil fertility status of organic and conventional lowland rice farming is still in low criteria [4]. However, the results of laboratory analysis showed that the pH, cation exchange capacity (KTK), nitrogen (N), and potassium (K) values of organic lowland rice farming in the transition year 2010 was higher than conventional lowland rice farming.

5. Acknowledgements

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