Soil physical properties and abundance of soil fauna in conventional and organic rice field

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Abstract. Land management affected the physical, chemical and abundance of soil fauna. The aim of the study was to know differences of soil physical properties and abundance of soil fauna in conventional and organic rice field. Another aimed to know long term effect of organic farming to soil physical properties and abundance of soil fauna in rice field. This experiment used nested design which 3 location of sampling. The first location was in Imogiri Subdistrict with conventional rice field and 6 years of organic rice field applied. The second location was in Mojogedang Subdistrict with conventional rice field and 4 years of organic rice field applied. The third location was in Sawangan Subdistrict with conventional rice field, 4 years and 10 years of organic rice field applied. Soil sample was taken in condition of after plough before planting, maximum plant vegetative phase and after harvesting. Organic rice field gave trend increased percentage of silt fraction and reduced percentage of sand fraction, increased aggregate stability of soil, increased abundance of earthworm, reduced abundance of plant parasitic nematode and increased non-parasitic nematode and increased soil respiration. Organic farming gave trend improving soil physical, chemical and biological parameters.

1. Introduction

Types of rice cultivation systems in Indonesia include conventional and organic systems. Conventional farming systems have been known for the use of chemical fertilizers and pesticides that are increasingly high in dosage and frequency of use. This increase in dosage causes the accumulation of nutrients from fertilizers or pesticides in the waters and ground water, resulting in environmental pollution. The soil will be saturated and damaged by the high-tech input. On top of that background began to develop an organic farming system that had long been done by the ancestors [1]. According to, the definition of organic agriculture is a system of agricultural production that is based on biological recycling. Recycling of nutrients can be through the means of crop and livestock waste, and other wastes that can improve the fertility status and soil structure.

According to [2], changes in soil physical properties that initially occur in rice fields is the result of puddling. The smoothing is done by treating the soil in a stagnant state, when the soil is plowed and then reprocessed which each process requires at least two times so that the aggregate of the soil is crushed into very soft sludge.

Penetration of soil is a reflection or a description of the ability of plant roots to penetrate the soil. The inclusion of plant roots into the soil depends on the root capability of the plant itself, the physical properties of the soil such as structure, texture and soil density, cracks in the soil, soil organic matter content and soil moisture conditions [3].
Land fauna is an organism that is all or most of its life cycle carried out in soil bodies as well as ground surfaces that play a role in helping to decompose organic matter [4]. According [5], soil fauna is part of the soil organism which is the main heterotroph group in the soil. Fauna along with other soil flora as a community inhabiting the land creates a unique, natural biogenic soil structure, and plays a role in the smooth process of nutrient cycling in the soil [6]. Some of the soil biota in the decomposition of organic matter are faunas belonging to protozoa, nematodes, insects, and earthworms. This soil fauna plays a role in the process of humification and mineralization or nutrient release, even taking responsibility for the maintenance of soil structures [7]. Nematodes obtain nutrients from different sources. Plants and animals can be hosts of one or more types of parasitic nematodes. In contrast, the free-living nematode species that prey on bacteria and fungi have obvious ecological functions such as their role in nutrient cycling in the soil ecosystem [8], [9] grouped the nematodes into five main groups on the basis of eating, namely (1) bacterial-feeders, (2) fungal-feeders, (3) predatory nematodes that ate all types of nematodes and protozoa, (4) omnivores that eat various types of organisms and (5) plant parasitic nematodes (plant parasites).

Respiration of soil microbes reflects the level of soil microbial activity. Soil microbial respiration measures are the first to be used to determine the level of soil microbial activity. Respiratory measures have a good correlation with other parameters related to soil microbial activity such as soil organic matter, N transform, pH and average microbial count [10].

The use of inorganic fertilizers and chemical pesticides causes a deterioration in soil quality. The use of chemical pesticides has the effect of decreasing the diversity of soil fauna. The soil is also a dynamic and complex habitat for the living of large numbers of organisms, including representatives from all groups of microorganisms, algae, and almost all animal phyla. Each group of microorganisms in the soil has an important role in maintaining soil quality and ecosystem balance, potentially as a sensitive biological indicator of environmental change [11]. The adoption of agricultural intensification has a negative impact such as decreasing the content of organic matter and increasing the density of the soil.

Organic farming system is considered a solution of soil quality improvement. The organic farming system is a land management with an ecological perspective and enhances biodiversity, soil hygiene and soil biology activities. With the organic farming system is expected to improve soil conditions and reduce the level of environmental pollution by chemical compounds derived from inorganic fertilizers and chemical pesticides. These conditions led to the need to conduct research on the effect of old soil organic management on the improvement of physical properties and abundance of soil fauna. Physical properties and abundance of soil fauna can indicate improved land quality.

2. Materials and methods
This research is a field survey research followed by laboratory analysis. The method used is the selected sampling (purposive sampling). Land sampling was conducted around May 2014 - January in Kebonagung Village, Imogiri Sub-district, Bantul Regency, DIY, Pereng Village, Mojogedang Sub-District, Karanganyar Regency, Central Java and Tirtosari Village, Sawangan District, Magelang Regency, Central Java. The experiment used Nested design with conventional organic (0 year organic) rice treatment system, organic system for 4 years, 6 years and 10 years. Soil sampling is done before planting and post harvest with 0-20 cm, 20-40 cm and 40-60 cm from the rice field. Laboratory analysis was carried out at the Laboratory of Soil Department and Nematology Laboratory, Department of Plant Protection, Faculty of Agriculture, GadjahMada University, Yogyakarta. Soil analysis consists of pH H2O, organic matter, particle size distribution, penetration resistance, aggregate stability, abundance of earthworm population, nematode abundance and soil respiration. The experimental data were analyzed by analysis of variance at 5% significance level then continued by Duncan test using SAS 9.1 software to know which treatment was significantly different.
3. Results

3.1. Actual pH (pH H$_2$O)

Based on the results of the analysis of variance, it is known that the old soil management treatment has an effect not significantly on the pH of soil H$_2$O at initial condition of planting (Pr> F = 0.0991) and gives significant effect on post-harvest condition (Pr> F = <0.0001). In the condition of some land (Figure 1) seen in the conditions before planting and vegetative phase maximum value of the highest pH H$_2$O shown on the land with the organic system Imogiri location with a value of 6.13 and 6.19. The highest post harvest condition of pH H$_2$O was shown on the 10-year-old organic site with a value of 6.24. The tendency to increase the pH value of H$_2$O is suspected as a result of the consistent addition of organic matter to organic rice field, thus increasing the soil pH value.

![Figure 1. Actual pH (pH H$_2$O) in study site](image)

It can be seen that the difference of land conditions influences the soil pH value with the tendency of pH value for the least initial planting conditions and post harvest condition to have the highest pH value. The increase in pH is also determined by: (1) the initial pH of the soil; (2) kinds and content of oxidized soil components, especially iron and manganese; and (3) kinds and content of organic matter [12]. The effect of adding organic matter to soil pH can increase or decrease depending on the degree of maturity of added organic matter and soil type. The addition of raw organic matter (e.g. green manure) or organic matter still undergoing the decomposition process, will usually lead to a decrease in soil pH, since during the decomposition process it releases organic acids causing decreasing soil pH. Giving organic matter to acidic soils with high Al content, will cause an increase in soil pH, because the decomposed organic acids will bind Al to form a complex compound (chelate), so that Al is no longer hydrolysed. It was reported that the addition of organic matter to acid soils, including Inceptisol, Ultisol and Andisol able to increase soil pH and be able to lower the altered land [13].

3.2. Soil Organic Matter

Based on the result of the analysis of variance, it is known that the old soil management treatments have no significant effect on soil organic matter either at the initial condition of planting, vegetative phase maximal or post harvest (Pr> F = 0.3142, Pr> F = 0.1103 and Pr> F = 0.4951). Based on the results of the DMRT test on the value of organic matter (Figure 2) shows that there is no significant difference in the long time of organic soil management both in the conditions before planting, vegetative maximum or post harvest. In pre-planting and vegetative phases, the maximum value of
organic matter was found to be on the land with organic soil management for 10 years Sawangan location with consecutive values of 3.15% and 3.24%. In post-harvest condition, the highest organic material value is found on land with conventional land management location of Imogiri with 2.99% value.

![Soil organic matter study site](image)

**Figure 2.** Soil organic matter study site

In general, the length of organic soil management gives a tendency to increase the value of soil organic matter. In the upper layer shows an increasing trend due to the long effect of the application of organic cultivation while in the lower layer shows the fluctuation of the value of organic matter. This condition is caused by the top layer is a layer of soil that has direct contact with the given organic material. On the difference of land condition shows the highest value at the maximum vegetative phase condition. The maximum vegetative phase has the highest value suspected because the given organic material is mature so that when analyzed shows high value. The consistency of giving organic materials either in the form of green compost, manure or plant residues on organic soil more intensively than conventional land given input in the form of synthetic chemical fertilizer have an effect on the value of organic matter. In the old condition the application of organic system of increase occurred is suspected due to soil biological condition of land have good marked by value of organic material of high decomposition. According to [14] rapid decomposition of plant materials supported and facilitated by conditions: (1) low content of lignin and wax in plant material, (2) the availability of adequate or sufficient nitrogen, (3) good conditions for the process of destruction chemically, (4) a good or favorable pH and (5) good aeration and with adequate moisture conditions for bacterial populations.

3.3. Distribution of Soil Particles

According to [15] soil texture is one of the important factors affecting soil capacity to retain water and soil permeability as well as various other soil physical and chemical properties. The soil texture consists of primary grains of a certain size. The USDA system classifies primary granules according to the grain diameter: very coarse sand (1-2 mm), coarse sand (0.5-1 mm), medium sand (0.25-0.5 mm), fine sand (0.1-0.25 mm), very fine sand (0.05-0.1 mm), dust (0.002-0.05 mm) and clay (<0.002 mm).

In general, the distribution of sand sand in various soil types (Figure 3) shows a tendency to decrease the percentage of sand is very coarse due to the long effect of land management with organic system. In contrast, the increase in the percentage of very fine sand and fine sand occurs due to the long effect of land management with organic systems. This increase has an impact on the increase of
soil micro pore, thus increasing water storage and aeration of roots and soil microorganisms. Suspected decrease of sand percentage is very rough due to weathering by soil organism activity. In line with the increase of dust fraction, intensive weathering is due to the addition of organic materials and management of environmentally friendly rice fields so as to maintain and increase the activity of soil organisms.

**Figure 3.** Distribution of sand fraction in some strength

3.4. Aggregate stability of soil

Aggregate stability can be interpreted as the aggregate resistance of the soil to an exerted influence both natural (water and wind) and mechanical (processing). The number obtained from dry sieves is an index that describes the sensitivity of the soil to wind erosion and the numbers obtained from wet sieves illustrate the sensitivity of the soil to water erosion [16]. Based on the result of the analysis of
variance, it is known that the old soil management treatment gives a significant effect to soil aggregate on the initial condition of planting and post harvest (Pr > F = 0.0004 and Pr > F = 0.0040).

Based on DMRT test results (Tables 1 and 2), there was a noticeable difference in the average age of organic aggregate stability. In land condition before planting and post harvest the highest aggregate stability value on land with organic soil management for 4 years with sequential value equal to 74.02% and 87.40%. The general aggregate stability value in pre-plant conditions is less than post-harvest condition. This occurs because at the time before the condition of planting land undergoing processing (piracy) which causes aggregate soil becomes damaged / destroyed. Generally, in every condition of the field, it is seen from the mean of age showing the fluctuating value and has no tendency to give significant impact to aggregate stability. The top layer shows a tendency to increase aggregate stability due to the length of organic soil management in each location. Factors affecting aggregate size and stability are texture, clay content, organic matter, and cation type. Clays and organic materials serve as adhesives in the aggregation process. Therefore, high clay content will increase aggregate size and stability.

**Table 1.** Aggregate stability of soil before planting (%)

| Depth (cm)   | 0   | 4   | 6   | 10  | Average |
|--------------|-----|-----|-----|-----|---------|
|              | MJ  | IM  | SW  | MJ  | IM     | SW     |
| 0-20         | 93.01 | 59.79 | 74.71 | 94.85 | 86.52 | 62.23 | 91.30 | 80.35 |
| 20-40        | 78.23 | 30.94 | 70.42 | 68.31 | 72.13 | 45.16 | 51.17 | 59.48 |
| 40-60        | 59.30 | 45.78 | 74.59 | 43.24 | 79.07 | 36.69 | 49.07 | 55.39 |
| Average location | 76.85a | 45.50b | 73.24a | 68.80a | 79.24a | 48.03b | 63.85a |
| Average of plant age | 65.20a | 74.02a | 48.03b | 63.85a |

Note: The numbers followed by the same letters in the column show no significant difference between treatment level 5%

**Table 2.** Aggregate stability of soil after harvesting (%)

| Depth (cm)   | 0   | 4   | 6   | 10  | Average |
|--------------|-----|-----|-----|-----|---------|
|              | MJ  | IM  | SW  | MJ  | IM     | SW     |
| 0-20         | 110.16 | 53.11 | 89.30 | 119.04 | 99.14 | 56.99 | 96.60 | 92.05 |
| 20-40        | 89.78 | 40.37 | 83.64 | 92.86 | 79.44 | 42.88 | 54.52 | 59.07 |
| 40-60        | 64.43 | 44.50 | 58.55 | 46.42 | 87.49 | 33.76 | 46.30 | 54.49 |
| Average location | 88.12a | 49.33b | 77.16a | 86.11a | 88.69a | 47.88b | 65.81ab |
| Average of plant age | 71.54ab | 49.33b | 77.16a | 86.11a | 88.69a | 47.88c | 65.81b |

Note: The numbers followed by the same letters in the column show no significant difference between treatment level 5%

Figure 4 distribution of MWD difference on various aggregate sizes for pre-planting and post-plant conditions. High MWD difference value in aggregate diameter 4.76 mm and 0 mm for 0-20 cm and 20-40 cm and 40-60 cm in 20-40 cm and 20-40 cm height seen high MWD difference in aggregate diameter 4.76 mm, 0.5 mm, 0.3 mm and 0 mm with a tendency to deepen the higher the value of MWD difference. The smaller the value of the MWD difference indicates good soil resistance to destructive power.

Seen on 0-20 cm herbs both in pre-planting and post-harvest conditions for aggregate diameters of 4.76 mm and 0 mm of conventional rice fields tend to be more easily eroded compared to organic rice fields. In 0-20 cm have a high resistance value because in this jeluk there is a process of pelumpuran and direct interaction with the addition of organic matter. Organic matter is also responsible for the cementation of the major particles to form a stable aggregate [17]. Decomposable organic matter given
to the soil is less effective in its role in assisting aggregation. While [16] mentions the formation and stability of soil aggregates depending on the nature and amount of clays and organic matter.

![Figure 4. Distribution of dry-wet sieve MWD difference](image)

**Figure 4.** Distribution of dry-wet sieve MWD difference
3.5. Detention of soil penetration

Ground resistance to penetration of a stake means is a composite index of soil density, moisture content, texture, and clay mineral type. Penetration resistance is a soil strength index on a measurement condition. Soil density, soil moisture content, texture, and clay minerals are the soil strength indexes. Penetration resistance will increase if water content and depth decrease [17]. In wetland the penetration is closely related to the layers of the plow. To measure penetration resistance, a simple device called penetrometer is pressed into the ground and the force occurring is observed in relation to the depth of the plating tread layer.

![Figure 5: Depth of plow pan and moisture content distribution](image-url)
Figure 5. visible the dynamics of the depth of the plow pan and moisture conditions in each land condition. Seen on the condition before planting the depth of the plating tread layer fluctuated. In the condition of maximum vegetative land and post-harvest conditions visible conventional rice fields tend to be deeper than organic fields. If connected with soil moisture condition before planting condition have penetration depth in conventional rice field deeper due to high moist condition that is highest level 58% with maximal depth 30 cm, while in organic rice field reaches depth of 30 cm that is land with organic soil management for 4 years and 6 years have a moisture content of 46% and 45% respectively.

According to research results [18] that penetration prisoners will increase rapidly when ground water content decreases. In the loose sandy soil texture the penetration resistance increases proportionately with the depth. This shows that the organic rice field has deeper depth of plow tread layer than conventional rice field. The waterproof layer / plating tread layers in the rice fields are advantageous from rice growing because the water will flow down (small infiltration). Dense layered layers (hardpan) are found on soils planted with rice for several years. This impermeable layer is formed from depositing iron compounds (ferries) and manganese as an oxide layer around the clay soil particles [19].

3.6. Earthworms

Based on the results of analysis of variance, it is known that the old treatment of soil organic soil gives a significant effect on the earthworm at the initial planting and vegetative conditions maximum (Pr> F = 0.0421 and Pr> F = <0.0001). While in the post-penen conditions known the old treatment of soil management in an organic manner gives no significant effect on earthworms on post-harvest condition (Pr> F = 0.9903).

| Location | Year after conversion | Rice phase | Average site |
|----------|-----------------------|------------|--------------|
|          |                       | Early      | Mid          | Harvest      |              |
| Sawangan | 0                     | 1.33bc     | 1.33b        | 1.33b        | 1.33         |
|          | 4                     | 3.33a      | 2.33b        | 6.30b        | 4.00         |
|          | 10                    | 2.33ab     | 1.00b        | 3.33b        | 2.22         |
| Imogiri  | 0                     | 0.67c      | 17.00a       | 3.67b        | 10.56        |
|          | 6                     | 1.00bc     | 6.67b        | 45.67a       | 17.78        |
| Mojogedang | 0               | 0.67c      | 2.67b        | 2.33b        | 1.89         |
|          | 4                     | 1.33bc     | 3.33b        | 2.67b        | 2.44         |

Note: The numbers followed by the same letters in the column show no significant difference between treatment at level 5%

DMRT test results (Table 3) showed there is a significant difference abundance of earthworms on the average place in Sawangan land. The highest abundance of earthworms in the land condition before planting was found in Sawangan field with the duration of organic management for 4 years i.e. 3.33 individuals / 5 dm³. In the maximum vegetative phase the highest abundance is found in Imogiri field with conventional management (0 organic years) i.e. 17 individuals / 5 dm³. For abundance in the highest post-harvest condition is found in Imogiri field with organic management for 6 years. Visible land conditions affect the abundance of earthworms significantly. The optimal abundance conditions of earthworms are in post-harvest conditions. According to [20] that the moisture conditions required for the growth of earthworms are around 15-30%. Under many water conditions, the respiratory worm's breathing will be disrupted and cause the earthworm to migrate to areas with good air circulation. In general, the tendency that organic rice fields increase the abundance of earthworms compared with conventional rice fields. States that pesticides come to the soil as a mixture of some
products, when the mixture gets into the soil can cause a major effect on the earthworm food on the surface and reduce the population of earthworms.

3.7. Nematodes

Based on the result of the analysis of variance, it is known that the old treatment of organic matter gives no significant effect on the parasite nematodes at the initial condition of planting and post harvest (Pr> F = 0.1500 and Pr> F = 0.4240). The maximum vegetative phase of the old organic treatments had a significant effect on soil parasite nematodes (Pr> F = 0.0295). The old treatment of soil management in an organic manner gave no significant effect to the non-parasitic soil nematodes in the initial conditions of planting, maximum vegetative and post-harvest (Pr> F = 0.6177, Pr> F = 0.4177 and Pr> F = 0.7819).

In Figure 6 the distribution of parasitic nematode abundance in the initial conditions of planting, the maximum vegetative phase and post-harvest shows decrease according to the depth of the soil. Abundance of parasitic nematodes in conventional rice field or without organic soil treatment showed higher value compared with organic rice. For the abundance of non-parasitic nematodes shows a similarity that the decrease in abundance of non-parasitic nematodes is in line with the decrease in depth. The decrease of abundance according to the depth is thought to be due to the availability of the nematode food. The same is true of [21] showed a significant decrease in nematode abundance starting at 20 cm of soil depth. Fluctuating abundance values are seen in the initial condition of planting. This is thought to be due to cultivation of land in rice fields and the process of puddling causes nematode translocation.
The soil moisture conditions have an effect on the abundance of both parasitic and non-parasitic nematodes. In sufficient moisture conditions and not flooded indicates optimal abundance. For the abundance of parasitic nematodes associated with organic duration has a tendency to decrease the abundance of parasitic nematodes due to consistent addition of organic matter. [22] suggests that crop residues may act as stimulants for soil antagonistic soil microorganisms against plant pathogens. The decomposition of organic matter produces heat and toxic gases so that the nematodes found in the rice plants of Hirschmanniella are not found on organic farmland. This study shows a corresponding result when it is associated with observed agricultural land, i.e. no genus of Hirschmanniella nematodes found in non-pesticide farmland. While for non-parasitic nematodes showed the tendency of increasing abundance due to the application of organic systems. According to [23], the application of livestock compost on organic farms increases the abundance of bakterivore nematodes compared to conventional farming. According to Handayanto&Hairiah (2007) nematodes have an ecological role of helping nutrient cycles, controlling the balance between bacteria and fungi and the composition of microbial communities, helping the distribution of bacteria and fungi, food sources and disease suppression.

3.8. Soil Respiration
Based on the result of the analysis of variance, it is known that the old treatment of soil management gives no significant effect on soil respiration at initial condition of planting (Pr> F = 0.0564). While in the old treatment of organic soil management gave a significant effect on soil respiration in the maximum vegetative phase and post-harvest (Pr> F = 0.0001 and Pr> F = <0.0001). The distribution of soil respiration tends to decrease with the depth of soil (Figure 7). At the initial condition of planting there is fluctuative value of soil respiration to depth. This is allegedly due to the processing of soil in the fields. In the maximum vegetative condition, organic trends tend to have higher respiration value than conventional rice field. The same thing happened in post-harvest condition where the value of respiration of organic rice field tend to be higher than conventional rice field. Decreased microbial activity is characterized by decreased soil respiration.

The highest value in the condition before planting is in the conventional rice field of Sawangan i.e. 0.089 mg CO₂ / g soil / day. In the initial condition of planting there is fluctuation of respiration value of soil due to processing on the rice field. Vegetation conditions of vegetai maximum and post harvest phase showed a tendency of increasing soil respiration due to organic soil management. The highest values of soil respiration in the maximum vegetative and post-harvest vegetation sequentially
were 0.166 mg CO₂ / g soil / day (Mojogedang rice field with organic soil treatment for 4 years) and 0.239 mg CO₂ / g of soil / day (conventional Mojogendang rice field).

If you look more detail at each location on land condition (plant phase), maximum vegetative land and post-harvest conditions have a higher soil respiration value than at the beginning of planting. This is allegedly due to the process of wetland farming at the beginning of planting so that the land becomes stagnant / anaerobic. The influence of moisture content on microorganism activity can occur directly or indirectly. Water content directly affects the condition of air circulation for the availability of oxygen in the soil. According to [24], water levels affect the decomposition process associated with dissolved oxygen levels, the higher the water content the availability of oxygen becomes low and will inhibit the aerobic decomposition process that will indirectly affect the rate of respiration. This effect causes the post-harvest condition to have the highest value compared to other land conditions.

**Figure 7. Distribution of soil respiration at some depth**

The result of [25] study stated that the addition of organic material is very effective to increase microbial activity of heterotrophic soil, i.e. bacteria that use organic compounds as carbon source or energy source. In addition, the addition of organic matter also increases the activity of actinomycetes and fungi that play an important role in the aggregation of soil particles (soil structure). The respiratory rate showed a positive correlation to the number of mild fractions of organic matter and the number of soil bacteria [26]. The same is expressed by [27] that the amount and activity of microorganisms in the soil is influenced by organic matter, aerated humidity and energy sources.

Soil microorganisms can generally live well on soils with a neutral pH. According to [28], the soil with a moderate pH range between 6-7 presents the most favorable conditions for living soil microorganisms. This condition is thought to cause the value in the conventional rice field location
Mojogedang has a higher respiratory value in addition to the clay mineral aspects that are contained and the moisture content. According to [29] clay minerals, especially monmorillonite can increase bacterial antagonism of Serratiamarcescens with Aspergillusniger fungi on agar medium. Clay monmorillonite minerals inhibit the growth and activity of fungi, instead spur the growth and activity of bacteria.

3.9. Relation of Organic Treatment and Soil Properties
Results of contrast analysis (Table 4) can be seen that the treatment of organic farming has not shown a singificant difference to conventional rice fields for the parameters studied. It is assumed that the organic farming treatment done by farmers has not been able to give significant improvement effect. The addition of the given organic material is thought to be breakeven meaning that the organic material provided is only sufficiently used by plants or residuals of organic matter for the improvement of relatively small soil properties. This condition is supported from the interviews of farmers that the addition of organic material is only done at the beginning of the planting year.

| Contrast               | db | Mean Square |          |          |          |
|-----------------------|----|-------------|----------|----------|----------|
|                       |    | Parastic Nematode | non-parasitic Nematode | Earthworm |
| Convensional vs Organic | 1  | 17312.10ns | 806.59ns  | 145.96ns |

| Contrast               | db | pH H₂O | Soil organic matter | Aggregate stability | Soil respiration |
|-----------------------|----|--------|---------------------|---------------------|------------------|
| Convensional vs Organic | 1  | 0.3325ns | 0.991ns      | 0.3509ns      | 0.0098ns        |

Note: ns = not significantly different

4. Conclusion
Organic rice management tends to increase the percentage of dust fraction and decrease the fraction of coarse sand, increase aggregate stability, increase abundance of earthworms, decrease abundance of plant parasitic nematodes and increase non-parasitic nematodes and increase soil respiration. Improvements in both the physical, chemical and biological properties of the soil due to the organic soil management in the past 10 years have not shown any significant improvement compared to the conventional rice fields.

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