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The Assessment of Soil Quality Index for Paddy Fields with Indicator Biology in Jatipurno Districts, Wonogirl

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Abstract

Increased rice needs in an extensive use of paddy fields in the Jatipurno, Wonogiri. Managing rice fields can reduce soil quality. Proper management can improve soil quality, Jatipurno has management such as organic, semi-organic and inorganic paddy field management which have a real effect on soil quality. Assessment of soil quality is measured by physical, chemical and biological indicators, where each factor has a different effect. The chemical indicators are often used as the main indicators for determining soil quality, whereas every parameter has the opportunity to be the main indicator. So, biological indicators can play indicators. The main indicators are obtained from the correlation test (p-values ≤ 0,05 - < 0,01) and Principal Component Analysis with high value, eigenvalues > 1 have the potential to be used as Minimum Data Sets. The result is biological can be able to use as the Minimum Data Set such as microbial carbon biomass, respiration, and total bacterial colonies. The Soil Quality Index (SQI) of various paddy management practices shows very low to low soil quality values. The management of organic rice systems shows better Soil Quality Index with a score of 0,20 compared to other management. The practice of organic rice management shows that it can improve soil quality.

Keywords: indicator biology, minimum data set, soil quality index, principal component analysis

1. Introduction

Increasing food needs give rise to the wide paddy fields to meet food consumption (Liu et al., 2014). Paddy field intensive management results in changes in soil quality that are low. There needs to be appropriate management to improve soil quality. Soil quality provides physical, chemical, and biological requirements for soul productivity, food quality and health, environmental safety of the animal and human plants (Doran and Parkin, 1994 ; Dengiz O., 2019).

Jatipurno Subdistrict is one of the sub-district in Wonogiri Regency. The use of rice fields in Jatipurno has an area of around 1322.14 ha or 25.20% BPS Wonogiri (2018) of the total land-use area. Based on data from the Research and Development Agency of the Ministry of Agriculture, 3,250 million ha of rice containing organic matter is less than 2% (Sitepu, Anas, and Djuniwati, 2017). This fact proves that rice fields have low fertility and soil quality. The long-term use of rice fields in Merauke has a low Soil Quality Index (SQI) of 0.33 (Supriyadi et al., 2017). Improper management of paddy fields use of inorganic fertilizers results in environmental pollution making (Zhao et al., 2016 ; Oladele., 2017) the Soil Quality Index low.

Organic farming systems can improve the soil quality of Sukristiyonobowo, Purwanto, B. H. and Husen, E., (2015) and the environment, especially about to with concerning biological activities in the soil, Mangunharjo village, Jatipurno, which has organic, semi-organic and inorganic management. Evaluation of soil quality in various practices in managing paddy fields is still small. The value of organic and inorganic rice soil quality in the Susukan area has a Soil Quality Index (SQI) value of 0.42 and 0.3 in the medium category (Mustikaningrum et al. 2018). Soil Quality Index (SQI) can be used for soil quality assessment (Doran and Zeiss, 2000; Larson et al. 1994) and SQI method easy in use and flexible when used with measurements (Reeves, D. W., 1997 ; Marzaioli R, D'Ascoli R, De Pascale RA, and Rutigliano FA., 2010 ; Fernandes JC, Gamero CA, and Rodrigues JGLMirás-Avalos, J. M., 2011 ; Liu Z, Zhou W, Shen J, Li S, and Ai C, 2014 ; Li P, Zhang T, Wang X, and Yu D., 2013). However, most calculations of soil quality are determined by chemical indicators. Even though each indicator has the same opportunity to be used as the main indicator to determine the soil quality. Indicators that are generally used as indicators of soil quality such as aggregate stability, specific gravity, pH, salinity, CEC, microbial biomass and respiration (Martinez-Salgado, Gutierrez-Romero, V. Jannsens, and Ortega-Blu, 2010).

The main problems with the implementation of soil quality indices are the classification of organisms at the specifies level, which needs to be sorted out by specialists and is time consuming. The species identification of soil organisms must be easy Breure A.M., Mulder C., Römbke J., and Ruf A., (2005) in the biomonitoring program of soil quality. The nature of organic matter is related to the availability of C and microbial biomass. These factors make biological indicators have potential as the main indicator. Biological activities are considered difficult to assess even though they have an important role in the characteristics of soil (Reeves, D.W.,1997). Naturally, soil organisms have an important role to play in managing and improving soil quality in a sustainable manner (BPS Wonogiri 2018). Appropriate management will have an impact on the safety of organisms in the soil Kouamé et al. (2004) that can improve soil quality (Chan et al. 2007). The transition of land from natural forest to intensive land use results in soil fertility Dinesh et al. (2003) and soil biology index (Islam et al. 2000). There is a need for research on the biological parameter of soil as a good indicator of Doran and Zeiss, (2000) the main key to assessing soil quality (Acosta-Martinez et al. 2007). The study of these problems is still small so there is a need to develop how much influence biological indicators determine soil quality, especially in the use of paddy fields in the Jatipurno area, Wonogiri. This research is expected to provide appropriate solutions regarding good soil quality, especially the influence of biological indicators on the process of increasing biological activity to improve the quality of paddy fields and increase rice production.

1.1 Introduce the Problem

The study is intending to adder following questions about :

How does the influence of agricultural management in paddy fields on land quality assessment mainly seen from biological factors?

1.2 Target and Inquires of Study

The study goal is to probe the assessment of soil quality index for paddy fields with indicator biology in Jatipurno Districts, Wonogiri through the following questions :

Question 1 : What are biological indicators as the main components that determine the Soil Quality Index (SQI)?

Question 2 : Is the quality of organic paddy soil better than semi-organic and inorganic paddy fields? ?

1.3 Importance of the Study

It is hoped that the following entities will benefit from the results of this study :

- Paddy fields in Jatipurno Districts: evaluating the influence of biological indicators as the main component to determine the value of paddy soil quality in Mangunharjo Village, Jatipurno, Wonogiri
- Researchers: assess the best quality of paddy soil in Mangunharjo Village, Jatipurno, Wonogiri

1.4 Definition

1. Paddy fields are the largest form of agricultural land use in Indonesia as a result of human activities (anthropogenic) which is influenced by the making or printing of rice fields and management or cultivation methods which are used as the main resources for producing basic foodstuffs such as rice. (Subgyayono, 2001).

2. Soil quality is the capacity of the functioning of a soil (Doran, J. W. and Parkin, T. B., 1994; Karlen et al., 1997; Shukla et al., 2006) is a collection of various indicators both physical, chemical and biological (Reeves 1997).

3. The Soil Quality Index as a tool used to determine sustainable soil management (Supriyadi et al, 2017)

4. Biological indicators have a cause and effect with some soil characteristics, especially in population and soil biota activity, so biology indicators are used as indicators of soil quality (Hadi et al. 2014).

1.5 Limitation

The study is limited in the following :

Place : Paddy fields with the management system organic, semi-organic and inorganic in Jatipurno District.

1.6 Previous Related Research

Some of the relevant studies are presented below for benefiting from their methodological procedures and theoretical literature they have included. They have been chronologically arranged from the oldest to latest :

A study by Gulser (2004) entitled " A Comparison of Some Physical and Chemical Soil Quality Indicators Influenced by Different Crop Science ", aimed to determine the changes in some physical and chemical soil quality indicators of clay soil under six different crop species in comparison to the fallow plots.

A study by Riches D, Porter I.J., Oliver D.P., Bramly R. G. V., Rawnsley B., Edwards J., and White R.E. (2013) entitled "Review: soil biological properties as indicators of soil quality in Australian viticulture" , aimed to recommendations for the inclusion of biological indicators as a component of an MDS for viticulture, based on their suitability, ease of measurement and current availability to the industry.

A study by Nwaichi E.O., and Chuku L.C entitled " Biological Soil Quality Indicators and Conditioners in a Plant-Assisted Remediation of Crude Oil Polluted Farmland", aimed to evaluate the possible effect of management practices on vital and relevant enzyme activities in petroleum polluted soil with a four-factorphytoremediation recovery attempts.

A study by Martinez-Salgado M,M, Gutiérrez-Romero, V., Jannsens, M. And Ortega-Blu, R. (2019) entitled " Biological soil quality indicators: a review" aimed to soil quality acquires an important dimension related to the strategies for conservation, health, good agricultural practices, and agroecosystems sustainability.

A Study by Supriyadi, S, Purwanto, Sarijan A. Mekiuw Y., Usiatik R., Prahesti R. R (2017) entitled "The Assessment of Soil Quality at Paddy Fields In Merauke, Indonesia"aimed to investigate any condition which has a correlation between the indicators and soil quality status of old and new paddy fields through the SQI.

A study by Mustikaningrum, I. A., Supriyadi, Herawati A., Purwanto P., Sumani S. (2018) entitled "Soil quality assessment in organic and non-organic paddy fields in Susukan , Indonesia" aimed to compare the soil quality on organic and non-organic paddy fields.

1.7 What Distigueshes this Study from Previous Studies

The previous study about the Soil Quality Index, which assessed funding for soil quality in Jatipurno District, prioritized biological indicators as the MDS that was the most difficult to achieve in the study of soil quality.

2. Method

2.1 Study Area

The study conducted at the paddy field sites of Mangunjarjo village, Jatipurno district, Wonogiri (fig. 1) (latitude 7°46'52" S dan 111°07'06" E. The research conducted in September-October 2018, with altitude 527 m above sea level. The type of soil in this area is Latosol (Red-brownish). To assess the changes management soil quality, the present study was conducted at the different management of organic paddy fields with the preparation of manure 3-4 tons/ha, semi-organic management with the provision of 1,5 – 2 kg/ha and 65 kg/ha of phonska fertilizer and management of inorganic paddy fields with phonska fertilizer of 100-125 kg/ha. The age of paddy in three management systems is 35-40 days.

2.2 Soil Sampling

The research carried out with a field survey using a purposive sampling method (criteria determined by researchers) with 9 sample points three replications. At each site, taking samples using diagonal method five quadrates (100 cm) and from each management paddy field, soil samples were collected (0-10 cm depth) and mixed thoroughly, where there is one determining point then we draw a diagonal line with a distance of 1 m then composite. Analyses of soil physical and chemical properties were carried out on a composite sample from the selected soil layer. For analysis of soil biological properties, fields moist soil samples were taken in ice boxes, transported to labolatory and stores +4℃ till their analysis.

2.3 Analytical Methods

Soil analyze methods include physics, chemical and a biological indicator conducted in the laboratory by the method such as soil texture by the piping method, bulk density was determined by the pycnometer method. Potential hydrogen was measured using pH meter (electrometric method). Total nitrogen was measured by the Kjeldahl method. Organic carbon (OC) was determined based on the Walkey Black rapid titration method. Cation Exchange Capacity (CEC), Base Saturation and Available K were determined based on Ammonium Asetat 1 N extraction. Exchangeable Aluminium was determined based on the saturation of potassium chloride. Available P was measured with the Olsen method. Respiration measured by the titrimetric method. Biomass carbon was determined by the fumigation method. Total colony measured by pour plate method. All of these analyses are based on (Balittan 2005).

2.4 Soil Quality Assessment

Soil quality assessment is a three-step process on the basis which the current tool was developed Andrews et al. (2002) such as a selection of the minimum data set (MDS), data normalization and integration of the indicator scores into soil quality index (SQI). That's tool can be applied to the variety of climate, soil type, management practices, and end-user goal. Consistent with data normality we used Pearson's correlation to analyze soil parameters. Soil physical-chemical and biological characteristics measured with Principal Component Analysis where select Principal Components with eigenvalues >1 (Andrews et al. 2002; Brejda et al. 2000; Reeves, D. W. 1997) and/or contribution to explaining variability 75%. For each of the PC selected based on the criteria above, identify variables with highly weighted factor loadings. A multivariate procedure such as Principal Component Analysis (PCA) Arekhi et al. (2010) and Loading Plot to get Minimum Data Set (MDS). That analyze to determine the most effective factors with influence on plot distribution, multivariate procedure. The selected data is then followed by Scoring (Si) based on (Chandel et al. 2018). Calculation of soil quality is done by summing the variable scores that have been multiplied by the Weight Index (Wi) Supriyadi el al., (2017) then classified according to Cantu et al. (2009) shown by in (Table 1).the final PCA based MSQI equation is as follows :

$$\text{MSQI} = \sum_{i=1}^{n} WiSi$$

where, Wi is the PC weighting factor, S is the indicator score for each variable.

Better soil quality and better performance of soil quality indicators, soil having a higher index score indicates.

Table 1. Soil Quality Index Classification

Soil Quality Index	*Value*	*Class*
Better	0,80-1	1
Good	0,60-0,79	2
Moderate	0,35-0,59	3
Low	0,20-0,34	4
Very Low	0-0,19	5

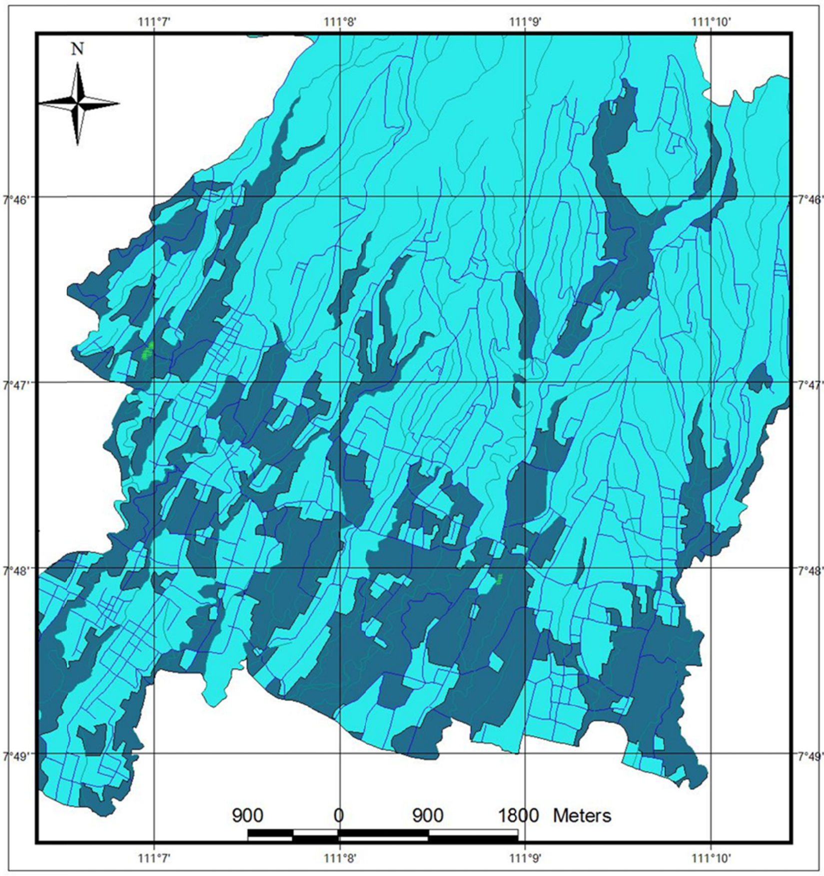

Figure 1. Overlay of map soil sampling

2.5 Statistical Analysis

T-test was carried out to compare the means of soil characteristics with respect to each management of paddy fields using a 5% T-test and if there were significant results it was continued by Duncan test on 5% levels.. For PCA, regression equations and score functions, Microsoft Excell and Minitab were used.

3. Results

3.1 Characteristic Soil Biology-Chemical-Physics in Three Sites

Biological, chemical and physical properties have different characteristics depending on the management of the soil. The condition of paddy fields in Jatipurno managed organically has better biological, physical and chemical values compared to semi-organic and inorganic management shown by in (Table 2). Analysis of biological indicators such as total colony, carbon biomass and microbial respiration in the management of organic paddy fields in Mangunharjo, Jatipurno has a higher value than semi-organic and inorganic management. According to research Wahyuni et al. (2016) that giving manure 20kg/ha increases the bacterial population to 105cfu/ml and according to Surekha (2013) that microbial respiration has a higher treatment with organic giving. The results of the Pearson correlation test showed that Total Colonies were significantly positively correlated with Carbon Biomass; Respiration; N total; P available; K available; and Organic C ($r = 0.92$ **, P-value = 0; $r = 0.699$ *, P-value = 0.036; $r = 0.814$ **, P-value = 0.008; $r = 0.886$ **, P-value = 0.001; $r = 0.678$ *, P-value = 0.045; $r = 0.951$ **, P-value = 0) can be seen in Table 2. According to Surekha (2013) between soil respiration, carbon biomass and total microorganism have an association with one another which is determined by the organic matter content.

The value of Cation Exchange Capacity in paddy fields in each system both organic, semi-organic and inorganic has a low CEC value and no significant influence between treatments. Cation exchange capacity is always in line with basic saturation. But the results of CEC analysis with Base Saturation did not correlate significantly. CEC analysis was positively correlated with available ($r = 0.766$, p-value = 0.016) can be seen in Table 2. because the mineralization process would increase K cations. According to Sufardi et al. (2017), high CEC is not always followed by high base saturation because CEC in tropical land does not always describe the number of cations that are absorbed by the soil but describes the cations adsorbed on the colloidal surface.

Table 2. Soil Characteristics, Biological-Chemical-Physical In Three Site

Sites	*Organic*	*Semi-organic*	*Inorganic*
Variables	*Mean*	*Mean*	*Mean*
Total Colony (CFU/gram)	6.9 x 105 b	1.8 x 105 a	1.2 x 105 a
Carbon Biomass (microgram/gram)	36.21±7,81 b	20.80±1,93a	14.72±1,46a
Respiration (lbs CO2 m^{-2} $hours^{-1}$)	11.24±5,50 c	8.21±3,94 b	4.34±8,51a
pH	6.37±0,58 b	6.27±0,58 b	6.03±0,12a
Cation Exchange Capacity (CEC) (me/100kg)	14.42±0,46 b	11.94±0,41a	13.30±1,39ab
Base Saturation (BS) (%)	28.79±12,37a	37.04±4,71a	25.15±6,92a
Total Nitrogen (%)	0.4±0,17 b	0.35±0,23a	0.31±0,23a
Organic Carbon (%)	2.37±0,57 b	1.13±0,21a	0.97±0,11a
Available P (mg/liter)	4.41±0,50 b	3.45±0,61 b	3.85±0,17ab
Available K (mg/liter)	2.93±0,75 b	1.42±0,18a	2.26±0,41ab
Exchangeable Alumunium (%)	1.79±0,62a	2.62±0,72a	3.06±1,23a
Bulk Density (gram/cm-3)	2.15±0,13a	2.24±0,61a	2.09±0,13a

Description: CEC = Cation Exchange Capacity; BS = Base Saturation, Values are mean +- standard error (n=27), different lowercase letters represent difference significant ($P < 0.05$).

The available value of organic management has a higher value compared to semi-organic and inorganic management. According to Sufardi et al. (2017) that the addition of organic materials such as rice straw and poultry manure has a high K content of 592 kg/ha of organic systems, and inorganic systems 548 kg/ha to increase K availability. Correlation test results that Kedia is available have a positive correlation significantly with Organic Carbon, Total Colony and Carbon Biomass ($r = 0.732$, $p = 0.25$; $r = 0.678$, $p = 0.045$; $r = 0.666$, $p = 0.05$) can be seen in Table 3.

The Mangunharjo rice field has Organic Carbon significantly due to management both organically, semi-organically and inorganically. Organic Carbon correlation results were correlated with Total Nitrogen, Available, and Available ($r = 0.767$, $p = 0.016$; $r = 0.933$, $p = 0$; $r = 0.732$, $p = 0.025$) can be seen in Table 2. Rice fields with organic systems have higher Organic Carbon content compared to other paddy fields. The provision of organic matter in rice fields with long periods will increase the Organic Carbon content in paddy soils (Chen et al. 2018).

The pH range is about 6.4 in both organic, semi-organic and inorganic rice fields. According to McCauley et al. (2018), soil pH affects nutrient availability because H + ions take the place of negative charge on the surface of the soil. The pH value of 6.4 is classified as slightly acidic or tends to be neutral. Low pH will result in Al being mobile (Darlita et al. 2017). The highest available value obtained in organic treatment. By following the study Sari et al. (2017) that there was an increase in P due to the addition of organic matter from 8.93 ppm to 19.56 ppm.

Table 3. Pearson's correlation coefficient of biological parameters with chemical and physics parameters

Variable	*Respiration*	*Biomassa Carbon*	*Total Colony*
Respiration (lbs CO_2 m^{-2} $hours^{-1}$)	-	0.856**	0.699*
Carbon Biomassa (microgram/gram)	0.856**	-	0.92**
Total Colony (CFU/gram)	0.699*	0.92**	-
Bulk Density/ (gram cm^{-3})	0.142ns	0.13ns	-0.11ns
pH (pH H_2O)	0.757*	0.653ns	0.543ns
Total Nitrogen (%)	0.725*	0.807**	0.814**
Organic Carbon (%)	0.809**	0.981**	0.951**
Cation Exchange Capacity (CEC) (me/100kg)	0.368ns	0.561ns	0.521ns
Base Saturation (BS) (%)	0.134	0.226ns	0.059ns
Exchangeable Alumunium (%)	-0.465ns	-0.664ns	-0.613
Available P (mg/liter)	0.891**	0.958**	0.886**
Available K (mg/liter)	0.277ns	0.666*	0.678*

*Significant ($P < 0.05$), ** Significant ($P < 0.01$), ns: No significant (n=27).

The weight of the type is related to the congestion of the soil. Bulk density has good balanced macro micro pores for developing microbial processes, root penetration, water retention and so on. According to Primadani et al. (2010) the lower soil density, it will make it easier for the roots to push the soil and break down the soil structure so that it becomes a way of aeration of the soil to hold and bind water and soil nutrients.

3.2 Soil Quality Index

Calculation of Soil Quality Index (SQI) with statistical applications in the form of Pearson Correlation Analyze and Principal Component Analysis (PCA). Analysis of the main components will produce PC data (Principal Component) or the main component. This PC data will be used to determine the Minimum Data Set (MDS) for the quality soil. Selected Principal Components are that have eigenvalues ≥1 (Cantu et al. 2009). From each selected PC, the highest values are taken, then it will be used as the weight index of the indicator in calculating the land quality index. This study PC1 to PC3 which is a PC that meets the requirements to become a data set with cumulative 84.3%, meaning that from the 8 indicators used to determine the Soil Quality Index of PC 1 to PC 3 (N-total, pH, available, Respiration, Organik Carbon, Base Saturation, Total Colony and Biomass have been able to represent 84.3% data. The results of MDS analysis using PCA can be seen in (Table 4)

Table 4. Principal Component Analyze of soil characteristic on the rice field

Eigenvalue[a]	**6,8848**	**2,0596**	**1,1724**
Proportion[b]	0,574	0,172	0,098
Cumulative[c]	0,574	0,745	0,843
Eigenvectors[d]			
Variable	PC1[e]	PC2[f]	PC3[g]
Capacity Exchange Cation	0,221	-0,49	0,143
Total Nitrogen	**0,322**	0,183	-0,171
Bulk Density	0,043	0,051	0,263
Available P	**0,361**	0,088	-0,012
Exchangeable Al	-0,27	0,097	-0,427
Respiration	**0,317**	0,185	-0,228
Organic Carbon	**0,37**	-0,083	-0,043
pH	0,265	**0,386**	-0,326
Available K	0,248	-0,374	0,179
Base Saturation	0,064	0,328	**0,706**
Total Colony	**0,355**	-0,11	-0,083
Carbon Biomass	**0,377**	0,007	0,041

[a] Boldface eigenvalues correspond to the PCs examined for the index.

[b] Boldface proportion is against the influence of the variable value on the Minimum Data Set

[c] Boldface cumulative the sum of the proportion up to the highest value has a value of 1

[d] Boldface factor loadings are considered highly weighted and include in the Minimum Data Set

[e] Boldface PC1 (Principal Component 1)

[f] Boldface PC2 (Principal Component 2)

[g] Boldface PC3 (Principal Component 3)

The indicators used as MDS soil quality are determined with the highest value in each PC that has been adjusted based on the longest plot and predetermined criteria (PC1 to PC3). The indicator with the highest value on PC1 is N-total, Available, Respiration, Organic C, Total Colony, and Carbon Biomass get the proportion per an analysis of 9.57% because it correlates with each other. PC2 consists of pH which has a proportion of 17.2%. Base Saturation on PC3 has a proportion of 9.8%. Determining Soil Quality Index is obtained from the selected PC indicator value to find the index weight value (Wi), where Wi is the proportion divided by cumulative results can be seen in (Table 5). The results of the weighting of the index are used to find the Soil Quality Index (SQI) by multiplying the scoring of the selected MDS analysis.

Table 5. Weight Index Calculation of Minimum Data Set

Minimum Data Set	*Proportion*	*Cumulative*	*Weight Index*[a]
Total Nirogen	0,096	0,844	0,113
Available P	0,096	0,844	0,113
Respiration	0,096	0,844	0,113
Organic Carbon	0,096	0,844	0,113
pH	0,172	0,844	0,204
Total Colony	0,096	0,844	0,113
Carbon Biomass	0,096	0,844	0,113
Base Saturation	0,098	0,844	0,116

[a] Weight index was obtained from the proportion divided by cumulative

Soil quality scoring based on Balittan (2005) can be seen in (Table 6). The results obtained from the calculation of the soil quality index are then classified according to (Cantu et al. 2009). Class of soil quality is divided into very good, good, medium, low and very low. Calculation of the Soil Quality Index (SQI) can be seen in (Table 7). Obtained from scoring, the minimum data set we can analyze consists of base saturation, total nitrogen, available P, respiration, organic carbon having a higher scoring value in organic processing compared to semi-organic and inorganic.

Table 6. Scoring of Minimum Data Set

No	*Minimum Data Set*	*Scoring*								
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	Base Saturation	1	2	3	2	2	2	2	1	2
2	Total Nitrogen	3	3	3	3	3	3	3	2	2
3	Available P	1	1	1	1	1	1	1	1	1
4	Respiration	2	2	2	2	1	1	1	1	1
5	Organic Carbon	3	2	3	2	2	1	1	2	1
6	pH	2	2	2	2	2	2	2	2	2
7	Total Colony	2	2	2	2	2	2	2	2	2
8	Carbon Biomass	1	1	1	1	1	1	1	1	1

Sample 1-3 is organic paddy fields; 4-6 is semi-organic paddy fields; 7-9 is an organic paddy fields.

The results (Table 7) obtained the Weight Index or Wi results per analysis from the proportion analysis that appeared in the main component multiplied by the scoring. Scoring results of all analyzes at each point were then added and modified according to (Cantu et al. 2009).

Table 7. Scoring Soil Quality Index On Rice Field With Several Systems

No	*Minimum Data Set (MDS)*	*Soil Quality Index (SQI)**								
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	Base Saturation	0,12	0,23	0,35	0,23	0,23	0,23	0,23	0,12	0,23
2	Total Nitrogen	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34
3	Available P	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11
4	Respiration	0,23	0,23	0,23	0,23	0,11	0,11	0,11	0,11	0,11
5	Organic Carbon	0,34	0,23	0,34	0,23	0,23	0,11	0,11	0,23	0,11
6	Potensial Hydrogen	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41
7	Total Colony	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23
8	Biomass Carbon	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11
Sum Soil Quality Index		0,19	0,19	0,21	0,19	0,18	0,17	0,17	0,17	0,17

*Soil Quality Index is the results from scoring x weight index

The results of the sample scoring in each analysis can be seen that the state of samples 1 2 and 3 which are included in organic conditions have a higher value of the Soil Quality Index. Larger Soil Quality Index Figures indicate a better value of data. Samples 4 5 and 6 which are included in semi-organic species have scoring that is between organic and non-organic. The transition of treatment between organic and non-organic has a positive impact on the quality of the soil. Inorganic treatments in samples 7 8 and 9 have lower scoring compared to organic and semi-organic samples. The use of excessive chemicals without the support of organic inputs will reduce the level of soil quality (Juarti 2016).

The results of the scoring in (Table 6) obtained results that affect base saturation, available P, organic C and respiration which have higher scoring results in organic management compared to semi-organic and inorganic management. The addition of organic matter can increase the cations on the soil surface which can provide nutrients for plants (Marthews 2014).

Table 8. Soil Quality Index On Rice Field With Several Systems

No	*Paddy Field Sites*	*Soil Quality Index*	*Soil Quality Classificated*
1	Organic	0,20	Low
2	Semi-organic	0,18	Very Low
3	Inorganic	0,17	Very Low

The results of the calculation of soil quality where the quality index is obtained from the scoring calculation multiplied by the index weight. The results obtained by soil quality index on land that has organic treatment have higher soil quality. Organic treatments have a soil quality index of 0.20 (low). The semi-organic sample treatment has a moderate soil quality of around 0.18 (very low). Inorganic or inorganic treatments have a soil quality value of around 0.17 which has a very low value. According to Mujiyo et al. (2018), the use of paddy fields with organic systems will change the quality of the land to be better if done in the long term. The levels of organic C-elements in organic systems have a higher value that can affect the number of microbes, C microbial biomass and microbial respiration which can increase biological activity to improve soil quality. The difference in management in the Mangunharjo rice field, Jatipurno has a significant difference after the T-test can be concluded that organic management affects better soil quality improvement with a p-value of 0.002 with inorganic and semi-biological management with a p-value of 0.010.

4. Conclusions

The quality of paddy soil in Mangunharjo Village managed organically has better soil quality compared to semi-organic and inorganic management with soil quality index values respectively 0.20, 0.17 and 0.15. Biological indicators which include respiration, microbial biomass, and total colonies can be used in determining the paddy soil quality index in Mangunharjo Village, Jatipurno District. Rice production using organic rice systems over for more than 6 years has a lower yield compared to the management of semi-organic and inorganic rice systems.

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