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Physicochemical Analysis of Organic and Inorganic Rice Farm Soils in Dumingag, Zamboanga Del Sur

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ABSTRACT

This study compared the physical and chemical parameters of the organic and inorganic rice farm soils in Dumingag, Zamboanga del Sur during 2015-2016. It sought answers to the following questions: moisture content, pH, particle density, and water holding capacity. 30 samples were collected and analyzed at Soil and Plant Analysis Laboratory, Central Mindanao University (CMU) – Maramag, Bukidnon.

Organic and inorganic rice farm soils in Dumingag have similar soil conditions, making organic farming more advantageous than inorganic farming. Fertilizers such as farmyard manure, animal manure, vermicast and synthetic fertilizers will be increased to improve soil condition. Analysis of physical and chemical parameters will be conducted in different periods of planting seasons to determine fertilizers and nutrients needed to increase yield. Other researchers should conduct studies to determine micronutrients and cost and return of organic and inorganic farming systems.

KEYWORDS: *Physicochemical Analysis, Organic and Inorganic, Rice Farm Soils*

INTRODUCTION

While the farmer holds the title to the land, actually it belongs to all the people because civilization itself rests upon the soil. ~Thomas Jefferson

Soil is a vital component and medium of unconsolidated nutrients and materials which form the life layer of plants. The fertility of the soil depends on the concentration of nitrogen (N), phosphorus (P), and potassium (K). A study was conducted to evaluate the physicochemical characteristics of organic and inorganic rice farm soils of Dumingag, Zamboanga del Sur. Nitrogen is the most important nutritional element, while potassium regulates transpiration, participates in the formation of sugars, and is used for flowering purposes. Organic matter improves the soil chemically by serving as a storehouse or supply of plant-nutrient elements.

In many farming systems, owing to continuous cropping, soil organic carbon (SOC) contents have diminished to unsustainably low levels and are an important cause of low water and nutrient use efficiency and systems productivity. Intensive soil tillage using hand hoes coupled with insufficient organic matter return to the soil are perceived as a major cause of land degradation (Ngwira, et. al.) [1].

Farming practices have undergone changes due to new technologies, such as heavy doses of fertilizers and other agrochemicals. This has led to the emergence of 'organic farming', which uses almost exclusively biological and natural materials and processes to produce food. It

aims to protect human health and conserve, maintain or enhance natural resources while being economically sustainable. Organic farming has grown rapidly throughout the world in recent years.

Published results of long-term trials of more than 30 years of side by side research demonstrate that organic farming is able to match conventional yields, outperforms conventional systems in drought years, builds soil, uses 45% less energy, produces 40% less greenhouse gases, and is more profitable than its comparable conventional system (IFOAM) [2].

Organic farming is increasingly being applied to different parts of the world, with one-third of the world's organic land being in Oceania. In the Philippines, farmers have adopted and adapted techniques inspired by biodynamic farming, permaculture and nature farming. The Local Government Unit (LGU) of Dumingag has developed the Genuine People's Agenda (GPA) to make Dumingag an organic capital.

The Local Government Unit encourages the farmers in Dumingag to practice organic farming. For several years of campaign, still there are farmers who are not practicing organic farming. These farmers are still using synthetic chemicals. Thus, the study was conducted to assess the physicochemical characteristics of organic and inorganic rice farm soils of Dumingag, Zamboanga del Sur.

Statement of the Problem

The study compared the physical and chemical parameters of the organic and inorganic rice farm soils in Dumingag, Zamboanga del Sur. It was conducted during the year 2021-2022.

Specifically, the study sought answers to the following questions:
1. What are the physical characteristics of the organic and inorganic rice farm soils in terms of:
    1.1 moisture content,
    1.2 pH,
    1.3 particle density, and
    1.4 water holding capacity?
2. Is there a significant difference on the physical characteristics (moisture, pH, particle density, water holding capacity) between the organic and inorganic rice farm soils?
3. What are the chemical characteristics of the organic and inorganic rice farm soils in terms of:
    3.1 nitrogen,
    3.2 phosphorus,
    3.3 potassium, and
    3.4 organic matter?
4. Is there a significant difference on the chemical characteristics (nitrogen, phosphorus, potassium, organic matter) between the organic and inorganic rice farm soils?

METHODOLOGY

This study utilized both descriptive and experimental research design using sampling method. Five (5) barangays (stations) for organic rice farms and five barangays (stations) for inorganic rice farms were established. Soil samples were collected from the established

stations and were used in the determination and analysis of the soil quality in terms of the physical and chemical characteristics.

The five organic rice farm sampling stations were the barangays of Marangan, Lower Landing, Upper Timonan, Maralag, and New Basak. A survey conducted by the Local Government Unit of Dumingag reveals that these barangays have been practicing organic farming for more than twenty (20 years) now. However, barangays Caridad, Bucayan, Upper Landing, San Pedro and Libertad were the inorganic rice farm sampling stations. In these barangays, most of the farmers are still using synthetic fertilizers to increase crop yield.

This study was conducted in the selected barangays in the municipality of Dumingag, Zamboanga del Sur. In gathering the data, the researcher chose five organic and five inorganic rice farms of Dumingag. The soil samples were collected from the surface depth (1 foot) using a digger. Soil samples were collected in three replicates from each sampling station of organic and inorganic rice farm soils. The collected samples were pulverized, mixed, and air dried. The collected soil samples were put in polyethylene bags and it were labeled accordingly. The samples were then taken to the laboratory for analyses. Due to unavailability of materials and equipment in the locality, the researcher decided to do the physical and chemical analyses of the samples at Soil and Plant Analysis Laboratory of Central Mindanao University (CMU), Maramag, Bukidnon.

Soil pH was determined using potentiometric method while particle density was determined using dry pycnometer. On the other hand, soil moisture content was analyzed through oven-drying method, and water holding capacity was analyzed using circular brass boxes.

Nitrogen, potassium, phosphorus, and organic matter were determined using modified kjeldahl method, flame photfmeter Method, bray P_2, and walkley – black method.

T-test was used in analyzing the data gathered in both organic and inorganic rice farm soils and was used to calculate the source of variations, degrees of freedom, and sum of squares. The calculated values were then tabulated.

Processing of data was done on the computer, using the software Statistical Package of the Social Sciences (SPSS), for more reliable and accurate results. The education discipline tools and devices were ordered to make the results more reliable and acceptable to the users of the research.

RESULTS AND DISCUSSIONS

Physical Parameters

The result on the analyzes of the different physical characteristics (moisture content, particle density, water holding and pH) of the organic and inorganic rice farm soils are shown in Table 1 and Table 2, respectively.

Organic Rice Farm Soils

As shown on the table, moisture content of the organic rice farm soils was found highest in barangay Maralag with a value of 20.590%. This was followed by Upper Timonan with 20.343%; next is New Basak with 20.283%; then Lower Landing with 19.907%; Marangan is the station with the lowest value of soil moisture content which is 19.340%. The overall average of moisture content for organic rice farm soil is 20.09%.

Therefore, results reveal that organic rice farm soils have low moisture content. This indicates that plant grown in this soil will be extremely stressed (Measurement Engineering Australia) [3].

In terms of particle density, data are expressed in terms of gram per cubic centimeter (g/cm^3). As reflected on the table, Lower Landing has the highest particle density of 2.467 g/cm^3; followed by Maralag, 2.446 g/cm^3; New Basak, 2.392 g/cm^3; Upper Timonan, 2.360 g/cm^3; and Marangan, 2.335 g/cm^3. The overall average for particle density is 2.40 g/cm^3. Results suggest that particle densities of organic rice farm soils are below the common range. The common range of particle density among soils is 2.55 to 2.70 g/cm^3 (Blake) [4].

As to water holding capacity of the organic rice farm soils, Marangan obtained the highest water holding capacity of 36.180%. Maralag has the second highest recorded water holding capacity of 32.490%; followed by Upper Timonan, 32.350%; New Basak, 31.987%; and Lower Landing, 31.620%. The overall average of water holding capacity is 32.93%.

Results reveal that the water holding capacity of organic rice farm soils is low. A study report showed that 1% increase in soil humus will result in a 4% increase in stored soil water and 1 part humus holds 4 parts of water. Therefore, the more humus that can be added to the soil, the greater the water holding capacity of the soil. As the level of organic matter increases in a soil, the water holding capacity also increases due to the affinity of organic matter for water (Acharya, et al.) [5].

In terms of pH, the highest average pH number of 6.283 was obtained by Upper Timonan. This was followed by Maralag, 6.173; Marangan, 5.893; Lower Landing, 5.743; and New Basak, 5.633 respectively. The overall average of pH number for organic rice farm soil is 5.95.Data reveal that the organic rice farm soils of the five stations were slightly acidic. Yet, the pH values of the soils were still within the ideal pH for rice which is 5.5 to 6.5 (The Mosaic Company) [6]. The five stations exhibited ideal favorable pH range.

Table 1. *Physical Characteristics of Organic Rice Farms Soils*

Stations	Physical Characteristics (Average from 3 Replicates per Station)			
	Moisture Content (in %)	Particle Density (in grams/ cm^3)	Water Holding Capacity (in %)	pH
1. Marangan	19.340	2.335	36.180	5.893
2. Lower Landing	19.907	2.467	31.620	5.743
3. Upper Timonan	20.343	2.360	32.350	6.283
4. Maralag	20.590	2.446	32.490	6.173
5. New Basak	20.283	2.392	31.987	5.633
Average	20.09	2.40	32.93	5.95

Inorganic Rice Farm Soils

The moisture content of the soil samples were found in between the range of 18.560% to 20.643%. As shown on the table, moisture content of the organic rice farm soils was found highest in Upper Landing with a value of 20.643%. This was followed by Bucayan, 20.543%; Caridad, 20.110%; and San Pedro, 19.650%. Barangay Libertad is the station with the lowest moisture content of 18.560%. The overall average of moisture content for organic rice farm soil is 19.88%. Results indicate that inorganic rice farm soils have low moisture content which imply that plants grown in this soil will be extremely stressed (Measurement Engineering Australia) [3].

In terms of soil particle density, the highest was recorded in Libertad, 2.449 g/cm^3 and the least was observed in Bucayan, 2.379 g/cm^3. Upper Landing yielded a particle density of 2.430 g/cm^3; San Pedro, 2.422 g/cm^3; and Caridad, 2.389 g/cm^3, respectively. The overall average for particle density is 2.41 g/cm^3.

Data show that the values of particle densities for inorganic rice farm soils are below the common range which is 2.55 to 2.70 g/cm^3 (Blake) [4].

With regard to water holding capacity, the highest value was measured in San Pedro, 34.243%. Upper Landing yielded a water holding capacity of 33.883%. This was followed by Bucayan, 32.757%; Caridad, 32.037%; and Libertad, 31.600%. The overall average of water holding capacity for inorganic rice farm soil is 32.90%. The results reveal just like the organic rice farm soils, the water holding capacity of inorganic rice farm soils was low because their organic matter content was also low.

As to the soil pH, highest average pH number of 6.500 was obtained by Bucaya. This was followed by Caridad, 6.113; Libertad, 6.000; San Pedro, 5.527; and Upper Landing, 5.490 respectively. The overall average of pH for inorganic rice farm soil is 5.93. Data disclosed that like the organic rice farm soils, the pH of inorganic rice farm soils was slightly acidic but was still favorable since it falls within the ideal pH range for rice which is 5.5–6.5 (The mosaic Company) [6].

Table 2. *Physical Characteristics Inorganic Rice Farms Soils*

Station	Physical Characteristics (Average from 3 Replicates per station)			
	Moisture Content (in %)	Particle Density (in grams/ cm^3)	Water Holding Capacity(in %)	pH
1. Caridad	20.110	2.389	32.037	6.113
2. Bucayan	20.453	2.379	32.757	6.500
3. Upper Landing	20.643	2.430	33.883	5.490
4. San Pedro	19.650	2.422	34.243	5.527
5. Libertad	18.560	2.449	31.600	6.000
Average	19.88	2.41	32.90	5.93

Chemical Parameters

Soil quality is measured not only by determining the physical characteristics of water but also the chemical characteristics especially its nutrient contents. The nutrients analyzed in this study included the organic matter, nitrogen, phosphorus, and potassium.

Organic Rice Farm Soils

In terms of the concentration of organic matter, the average organic matter content of the organic rice farm soils in the five station ranges from 1.196% to 3.358%.

It was found highest in New Basak, 3.358%. This was followed by Upper Timonan with a concentration of 2.990%; Marangan, 2.852%; and Maralag, 2.622%, respectively. Lower Landing obtained the lowest organic matter concentration of 1.196%. Overall, organic matter exhibited an average concentration of 2.60 %. Based on table 4 (Aventis CropScience Philippines, Inc.) [7], the categorical level of organic matter (OM, %) for rice ranges with values, <2.0 %, 2.0 –3.5%, 3.5 – 5.0 %, 5.0 – 8.5 % and >8.5 % inclusive for very low, low, medium, high and very high organic matter, respectively. Therefore, data suggest that organic rice farm soils of the five stations have organic matter content less than 3.5% which is interpreted as low.

Analysis of the Nitrogen content of the soil revealed that the highest nitrogen concentration was found in Upper Timonan with 0.200%. Next was New Basak, 0.190%. This was followed by Maralag, 0.187% and Marangan, 0.173%. Lower Landing obtained the lowest nitrogen concentration of 0.130%. The overall average of nitrogen concentration for organic rice farm soil is 0.18%. As shown in table 4 (Aventis CropScience Philippines Inc.) [7], the categorical level of total nitrogen (Kjeldahl N, %) for rice ranges with values, <0.10%, 0.10–0.2%, 0.21–0.50%, 0.51–0.75% and >0.75% inclusive for very low, low, medium, high and very high total nitrogen, respectively. Based on the data, the nitrogen concentration of the organic rice farm soils in the five stations ranges from 0.130% to 0.200%, interpreted as low.

In terms of phosphorus concentration, values ranged from 1.991 ppm to 7.340 ppm. High phosphorus concentration of 7.340 ppm was obtained by Lower Landing while Marangan yielded with the lowest concentration of 1.991 ppm. New Basak yielded a phosphorus concentration of 3.400 ppm; Maralag, 3.069 ppm; and Upper Timonan, 2.358, respectively. The overall average of phosphorus content for organic rice farm soil is 3.63 ppm. Based on table 4 (Aventis CropScience Philippines, Inc.) [7], data show that no station has sufficient available phosphorus. All stations fall within the range of <10 ppm which indicates low level of available phosphorus.

With regard to the average concentration of potassium in the five stations, the highest was recorded in Maralag with a value of 153.000 ppm. This was followed by Marangan with a concentration of 89.000 ppm. Next was Upper Timonan, 84.000 ppm, and Lower Landing, 37.000 ppm. The lowest value of 35.000 ppm was obtained in New Basak. The overall average of potassium content for organic rice farm soil is 79.60 ppm. According to

Ilagan, et al [8], optimum potassium requirement of rice were 1.8-2.6%, 1.4- 2.0% and 1.5-2.0% in the tillering to panicle initiation stage, flowering stage and maturity stage respectively. Table 4 shows that available K (ppm) for rice ranges with values 20-80 ppm and 82-246 ppm representing low and high available potassium, respectively. Results indicate that the potassium concentration of Maralag, Marangan, and Timonan fall within the range of

82- 246 ppm, interpreted as high, while Lower Landing and New Basak had low potassium concentration as evidenced by the concentration within the range of 20-80 ppm, categorized as low.

Table 3. *Chemical Characteristics Organic Rice Farms Soils*

	chemical Characteristics (Average from 3 Replicates per Station)			
	Organic Matter (in %)	Nitrogen (in %)	Phosphorus (in ppm)	Potassium (in ppm)
1. Marangan	2.852	0.173	1.991	89.000
2. Lower Landing	1.196	0.130	7.340	37.000
3.Upper Timonan	2.990	0.200	2.358	84.000
4. Maralag	2.622	0.187	3.069	153.000
5. NewBasak	3.358	0.190	3.400	35.000
Average	2.60	0.18	3.63	79.60

Table 4. *Decision Criteria Used for Interpretation of Soil Analysis*

Parameter	Range	Interpretation
pH	<5.0	Very Low
	5.5 – 5.5	Low
	5.5 – 6.0	Fair
	6.0 – 6.5	High
	6.5 – 7.0	Very High
Organic Matter (OM), %	<2.0	Very Low
	2.0 – 3.5	Low
	3.5 – 5.0	Fair
	5.0 – 8.5	High
	>8.5	Very High
Nitrogen (N), %	<0.10	Very Low
	0.10 – 0.20	Low
	0.21 – 0.50	Fair
	0.51 – 0.75	High
	>0.75	Very High
Phosphorus (P), ppm	<10	Very Low
	10 – 15	Low
	15 – 25	Fair
	25 – 35	High
	>35	Very High
Potassium (K), ppm	20 – 80	Low
	82 – 246	High

Inorganic Rice Farm Soils

Analysis of organic matter content of the soil revealed that the concentration of the five stations ranges from 2.116% to 3.358%. The highest organic matter concentration was found in Upper Landing with 3.358%. Next was Bucayan with a concentration of 3.036%. This was followed by Libertad, 2.576%; and Caridad, 2.484%. San Pedro obtained the lowest concentration of 2.116%. The overall average for organic matter content of inorganic rice far soil is 2.71%. The results show that the stations for inorganic rice farm soils of the five stations have organic matter percentage less than 3.5% which is interpreted as low according to Aventis CropScience Philippines, Inc. categorical level.

Comparing the average concentration of nitrogen in the five stations, it was highest in Upper Landing with a value of 0.240%. This was followed by Libertad with a concentration of 0.200%; Caridad, 0.183%; and Bucayan, 0.177%. The lowest value of 0.143% was obtained by San Pedro. Overall, nitrogen exhibited an average concentration of 0.19%. Results suggest that the nitrogen concentration of the inorganic rice farm soils in the four stations (Caridad, Bucayan, San Pedro, Libertad) falls within the range below 0.20%, interpreted as low, based on the categorical level for nitrogen content stipulated by the Avantis CropScience Philppines Inc. [7]. However, only one station, Upper Landing had a concentration of 0.240%, interpreted as medium, which indicate a desirable nitrogen concentration.

In terms of the concentrations of phosphorus of inorganic rice farm soils in the five stations, values range from 2.239 ppm to 8.341 ppm. Phosphorus concentration was found to be highest in Bucayan, 8.341 ppm. This was followed by Caridad with a concentration of 5.793 ppm. It was then followed by Libertad and Upper Landing with concentrations of 3.922 ppm and 3.318 ppm, respectively, while San Pero obtained the lowest phosphorus concentration of 2.239 ppm. Overall, the five stations exhibited an average phosphorus concentration of 4.72 ppm. Based on the categorical level of available phosphorus given by the Aventis CropSciencce Philippines Inc., the phosphorus content of the inorganic rice farm soils of the five stations fall within the range of <10 ppm which indicates very low level of available phosphorus. The same with the organic rice farm soils, inorganic soils have also low amount of available phosphorus.

With regard to the potassium concentration measured in the five stations values ranged from 45.000ppm to 190.000 ppm. High phosphorus concentration of 190.000 ppm was obtained by Bucayan while San Pedro yielded with the lowest concentration of 45.000 ppm. Caridad yielded a potassium concentration of 77.000 ppm; Libertad, 56.000 ppm; and Upper Landing, 46.000 ppm, respectively. Overall, potassium exhibited an average concentration of 82.80 ppm. Data suggest that the inorganic rice farm soil stations of Caridad and Bucayan yielded a potassium concentration within the range of 82- 246 ppm, interpreted as high. The rest of the stations (Upper Landing, San Pedro, Libertad) have low available potassium as evidenced by their potassium concentrations within the range of 20-80 ppm, interpreted as low.

Table 5. *Chemical Characteristics Inorganic Rice Farms Soils*

Stations	Chemical Characteristics (Average from 3 Replicates per Station)			
	Organic Matter (in %)	Nitrogen (in %)	Phosphorus (in ppm)	Potassium (in ppm)
1. Caridad	2.484	0.183	5.793	77.000
2. Bucayan	3.036	0.177	8.341	190.000
3. Upper Landing	3.358	0.240	3.318	46.000
4. San Pedro	2.116	0.143	2.239	45.000
5. Libertad	2.576	0.200	3.922	56.000
Average	2.71	0.19	4.72	82.80

Table 6. *Test of Significant Difference of Physical Characteristics Between Organic and Inorganic Rice Farm Soils*

Parameters	T-Test Value	df	p-value	Decisions
1. Moisture Content	0.486	8	0.640	Not Significant
2. Particle Density	0.490	8	0.638	Not Significant
3. Water Holding	0.022	8	0.983	Not Significant
4. pH	0.084	8	0.935	Not Significant

As shown in the table, the testing of the hypothesis for the physical characteristics (moisture content, particle density, water holding capacity and pH) yielded probability values that are higher than the 0.05 level of significance in all parameters which established no significant difference in physical characteristics of organic and inorganic rice farm soils. This implies that the moisture content, particle density, water holding capacity and pH values measured in both organic and inorganic rice farm soils are almost the same. Therefore, there is no significant difference on the physical characteristics between organic and inorganic rice farm soils in Dumingag, Zamboanaga del Sur.

Table 7. *Test of Significant Difference of Chemical Characteristics Between Organic and Inorganic Rice farm Soils*

Parameters	T-Test Value	df	p-value	Decisions
1. Moisture Content	0.256	8	0.804	Not Significant
2. Particle Density	0.629	8	0.547	Not Significant
3. Water Holding	0.758	8	0.470	Not Significant
4. pH	0.092	8	0.929	Not Significant

As shown in the table, the testing of the hypothesis for chemical characteristics yielded probability values that are higher than the 0.05 level of significance in all parameters and established no significant difference in chemical characteristic between organic and inorganic rice farm soils. This implies that the organic matter, nitrogen, phosphorus, and potassium contents of organic rice farm soils were almost the same with the inorganic rice farm soils. Potassium is used for flowering purposes; it is also required for building of protein, photosynthesis, fruit quality and reduction of diseases (Chaudhari) [9].

CONCLUSIONS

Results show that the physical and chemical parameters of organic rice farm soils are almost the same with the inorganic rice farm soils. Results assert that there is no significant difference between the physical and chemical characteristics of organic and inorganic rice farm soils in Dumingag. Since organic and inorganic farming have similar soil conditions, it is expected that the two farming systems have the same soil productivity. However organic farming is environment-friendly compared to inorganic farming, therefore, organic farming system is more advantageous than inorganic farming.

Recommendations

1. That application of fertilizers such as farmyard manure, animal manure, vermicast and synthetic fertilizers will be increased to improve soil condition.

2. That the analysis of physical and chemical parameters for organic and inorganic rice farm soils (surface and subsurface) will be conducted in different periods of planting seasons to determine the fertilizers and nutrients needed by soil to increase the percentage yield of the crop.

3. That researchers would conduct similar study on physical and chemical characteristics of rice farm soils in the subsurface to determine if there is increase in nutrients from surface level to deep level.

4. That other researchers should conduct another study to determine the micronutrients of organic and inorganic rice farm soils and analyze the physical and chemical characteristics of soils of different crops in Dumingag. Furthermore, they are also encouraged to conduct a study on the cost and return of organic and inorganic farming system.

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