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Fertility Status of Soils from Agricultural Area Samar, Philippines

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ABSTRACT— Philippine nutrient uptake of soil constraints from crop geospatial distribution of land. The Samar provinces of the municipality are Matuginao, Gandara, San Jorge, San Jose de Buan, Calbiga, and Paranas. These six municipalities were conducted to examine soil that has low fertility and nutrient status. Results showed that four textural classifications of soil properties included loam, silt loam, sandy loam, and sandy clay loam. Generally, Samar has a deficient amount of P (phosphorous) and K (potassium) as attributed by a high amount of Ca (calcium) enable to displace P and K from the crops soil environment. The greater amount of production inputs of P and K containing fertilizers are highly recommended in growing various types of crops, especially in upland agricultural areas. The lowland agricultural areas are highly suitable for crop production than in upland areas.

KEYWORDS: Soil Fertility, Nutrient status

1. INTRODUCTION

The socio-economic progress of Samar will remain a far-fetched dream that will remain a dream far beyond reality. Samar is an agricultural island and its economy depends primarily on agricultural production. The majority of its labor employment is in this sector, hence economic growth can be determined based on its agricultural harvest and production. As an agricultural island is expected to register the highest or perhaps belong to the provinces that produce the highest domestic product in agriculture. But data shows that Samar laps behind on this economic indicator as compared to its neighboring provinces. In the latest data released by the government, the Eastern Visayas Region where the province is part of registered as one of the regions that have a high poverty incidence rate. Along with this, the Eastern and Northern Samar was named as one of the poorest provinces of the county. This information only indicates that the socio-economic performance of these provinces which centers on agricultural production is very low. The data above only indicates that Samar will always remain a liability of the national government as it cannot achieve agricultural sustainability. There-into, the researchers find it ironic that though Samar has greater agricultural potential but still, it cannot attain agricultural sustainability. Hence, to answer the above-mentioned problems, and as the government's effort in attaining agricultural sustainability and finally to uplift the socio-economic status of the province, this particular research undertaking has been conceptualized. Besides, this study aims to the full agricultural potential of Samar, making it an asset not a liability of the national government. Primarily, the study aims to maximize the full agricultural potential of Samar, thereby attaining agricultural sustainability which revitalizes economic productivity, reduced poverty in the locality, the region, and that of the nation in general. To crop suitability classification is an effective strategy to cater to the needs of farmers within the region. But the said map did not classify the nutrient content status or the physico-chemical soil properties within the specific area as evidence to the crop suitability establishment and only signifies a subjective means of classification which could probably come from an unreliable secondary data source of information. To Samar region, Matuginao, Gandara, San Jorge, San Jose de Buan, Calbiga, and Paranas were limited findings established about the fertility and nutrient status of its sedimentary soil conditions. The [1] revealed that the soil derived from mudstone in Samar had a low or deficient fertility level of NPK content which also showed similar findings in degraded upland areas. Although not within the vicinity of farmers' cultivated land areas studies concentrated on degraded soil and mudstone- derived soil condition of the six municipalities of Samar. Thus, it is essential to conduct rapid nutrient analysis to develop good agricultural management strategies for sustainable crop production in Samar. It will provide a piece of more or less accurate information to farmers and agricultural technicians which serves as an avenue towards site-specific crop management practices within and nearby municipalities of the Samar region.

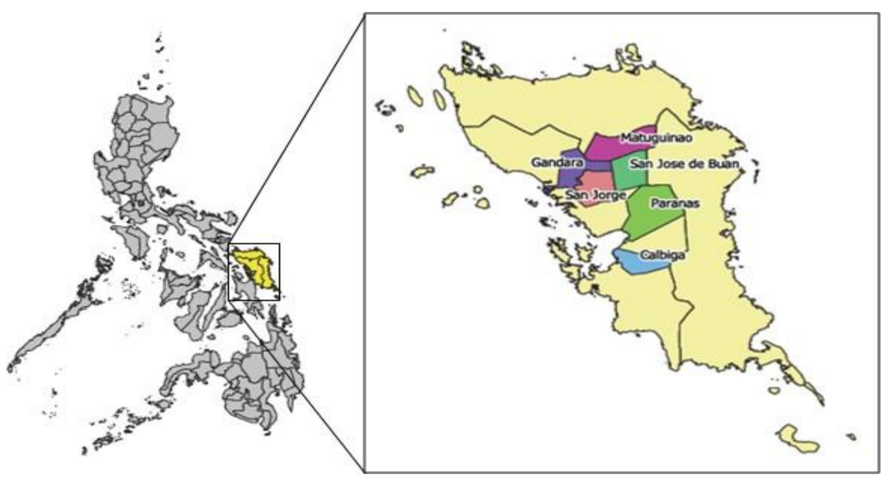
2. Materials and Methods

2.1 Description of the Study Area

Samar region is determined to be located at 12.24460 North to 125.03880 East which was situated along in the Eastern Visayas (Region VIII) of the Philippine archipelago. The Samar province was the third- largest island and it has three provinces namely; Eastern Samar, Northern Samar, and Samar (Western Samar). It was also ranked as the second on poverty level incidence after Northern Samar [2]. Type IV climate (has a year-round distribution of rainfall and a short period of the dry season) was usually observed from February to May. The flooding incidence in this region was more prevalent due to the lack of vegetation covering upland areas brought about by improper land use. As a consequence, soil degradation occurs in most of the areas in Samar province.

2.2 Selection of the Study Area

Basic criteria in the selection of sampling sites were the presence of dominant areas of agricultural land in the municipality (Fig.1). It was determined through preliminary secondary data gathering of information from the municipal agriculture office in every municipal site. There six municipalities (San Jorge, Gandara, Matuginao, Calbiga, San Jose de Buan, and Paranas) were purposively selected as sample sites that have potentially provide a major contribution to the agricultural industry.



A B

Fig. 1. The location of the study area. [Philippines (A), Samar (B)]

2.3 Data Collection

The divided was field into different homogenous units based on the visual observation and farmer's experience. Removed was surface litter at the sampling spot of 1 cm on the top. Drive was the auger to a plow depth of 3 x 3 x 30 cm. A draw slice was removed of soil and placed in a clean container. Mixed the samples thoroughly and removed foreign materials like roots, stones, pebbles, and gravels. Then, reduced the bulk to about half to one kilogram by quartering or compartmentalization. By quartering was done by dividing the thoroughly mixed sample into four equal parts. The two opposite quarters were discarded and the remaining two quarters and obtained remixed and the process repeated until the desire sample size. Compartmentalization was done by uniformly spreading the soil over a clean hard surface. Divides into smaller compartments by drawing lines along and across the length and breadth. From each compartment, a pinch of soil was collected. This obtained process was repeated till the desired quantity of sample. Collected the sample in a polythene bag. Labeled the bag with information like the name of the farmer, location of the farm, a previous crop grown, present crop, date of collection, and name of the sampler. After the profile has been exposed, clean one face of the pit carefully with a spade and notes the succession and depth of each horizon. Pricked the surface with a knife or edge of the spade to show up structure, color, and compactness. Collected samples starting from the bottom- most horizon first by holding a large basin at the bottom limit of the horizon while the soil above was loosened by a trowel. Mixed the sample and transfer to a polythene bag and label it.

2.4 Laboratory soil analyses

2.4.1 Subsample collection

A wooden mallet was used to spread the soil on a polythene sheet on a hard surface and powdered the sample by breaking the clods to their ultimate soil particle. Sieved to the soil material through 2 mm. They repeated the powdered and sieved until only materials of >2 mm (no soil or clod) were left on the sieved. It then collected the material passing through the sieve and put it in a polythene bag with proper labeling for laboratory analysis. For the determination of the organic matter, it was desirable to grind a representative sub-sample and sieved it through 0.2 mm. If the samples were meant for the analysis of micronutrients at-most care was needed in handling the sample to avoid contamination of iron, zinc, and sulfur.

2.4.2 Chemical Properties

The centers for fundamental nutrients play a key role in Central Analytical Service Laboratory, PhilRootcrops, VSU, Baybay City, Leyte, Philippines. Soil samples were analyzed for pH, percent OM, and N; available P; exchangeable K, Ca, Fe and Zn; and extractable Sulfate Soil pH was analyzed using a 1:2:5 soil-water ratio [3]. Organic matters were determined using the Walkley-Black Method [4]. Analysis of total N was done according to the micro-Kjeldahl method [3], Exchangeable bases (K and Ca) were extracted by the 1N NH4OAc (pH 7.0) method according to [3] in which the quantification was achieved with the use of the atomic absorption spectrometer (Varian Spectra 220 FS). Exchangeable acidity (Fe and Zn) was analyzed using 1N KCL as extractant and quantified by titrating the extract with 0.1 N NaOH [5]. The extractable SO_4-2-S of soil was extracted by 0.025 M KCl and determined by using ICP-OES [6]. Extractable micronutrients that were extracted using DPTA extraction were determined using Atomic Absorption Spectroscopy method.

2.4.3 Analyses and Data Interpretation

The fertility status of the result of soil analyses was compared and matched with the optimum soil requirement for an effective and efficient crop accurately estimated by soil solution testing.

2.5 Soil texture triangle in bottles

Put a bottle of soil and fill it with water and then, the bottom was a layer of sand. In the middle was a layer of silt and on the top was a layer of clay. If the water was still not clear, it was because some of the finest clay was still mixed with the water. On the surface of the water, there may be bits of organic matter floating. Measured the depth of the sand, silt, and clay and estimated the approximate proportion of each. Stirred the water and soil well, put the bottle down, and do not touch a day. At the end of a day, the water will have cleared and observed if larger particles have settled affect rate.

3. Results and Discussions

3.1 Physical Properties-Particle Size Soil Sample

Samar is naturally categorized as a sedimentary island [1]. Generates a low nutrient status of the soil due to the domination of high calcium carbonate at once degrade and transform mudstone [7]. This will create major fertility constraints in the process of crop production. The textural physical properties of soil from different municipalities vary accordingly from every municipality as well as its sampling sites (Barangay) except in Matuginao where uniform sandy loam texture was classified for three upland sites because the majority of the landscape were located in upland areas (Table 1). The presence of higher percent sand particles reflects the presence of mudstone derived from sedimentary rocks that enhances percolation [8]. This type of soil still possesses desirable soil composition for farming with good soil aeration and moderately available percent silt and clay able to support plant nutrients availability. The area was covered with high vegetation which significantly contributes much to the weathering process due to higher accumulation of organic ligand which was reported by [9]. The municipality of Gandara was located on the adjacent part of the municipality of Matuginao. Its upland areas have silt loam type of soil which has good moisture retention. On the other hand, the lowland site was determined to have silt loam and loam soil type of texture with the greater amount of silt observed. This indicates the active discharge of soil brought about by soil erosion or downstream siltation process was evident. The area was classified to have good soil textural properties to retain enough moisture, good aeration for better root penetration, and sufficient nutrient absorption. The adjacent side of Gandara was the municipality of San Jorge. The upland area had clay loam and sandy loam types of soil having a higher amount of clay and sand ratio, respectively. The higher clay compound could be inherited from the weathered mudstones as parent material with little or no transformation [10]. Meanwhile, in the lowland area, a loamy type of soil texture was developed which could probably due to a higher amount of silt deposited downhill caused by excessive soil erosion.

Across the west mountain part of San Jorge lies the Municipality of San Jose de Buan. The upland areas possess a sandy loam texture type soil. Unlike in Matuginao, the area had only limited vegetation due to successive production of upland rice farming. Farmers usually performed the slash and burn method of cultivation making the upland denuded as less amount of silt and clay components were observed in the area. The presence of the high amount of sandstone settled during the bottle test proved that the area was highly denuded which might be caused by overfarming. As a result, it leaves the soil uncovered and directly exposed to excessive erosion where silt and clay components easily leached out. Thus, there was a need to conserve the soil to enhance and maintain the soil fertility status of the area. While, flat-upland areas possess a loamy soil condition where silt build-up was prominent in the area and thereby, making the soil desirable for farming. The municipality of Paranas was located in the middle part of Samar. The upland areas have sandy loam types of soil. Indicating that it was dominated by the presence of mudstone soil particles and less on silt and clay. The lesser portion of silt and clay were deposited to lowland areas improving the soil texture into the loamy type of soil. This provided a better composition of the medium which make it more desirable for farming. The southern part of Paranas, where the Municipality of Calbiga was situated. The result of textural properties in upland areas showed that it has a sandy clay loam type of soil. It retained much moisture due to the presence of the moderate amount of clay and silt components which was then noticed during sample collection. The higher clay content in the area reflects the good yield of taro (butig) production met by most farmers where taro thrives best. On the contrary, the lowland part also has a sandy loam type of soil texture which was also desirable for farming though organic soil still needs to be applied. The results showed that four textural

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classifications of soil properties were determined which include loam, silt loam, sandy loam, and sandy clay loam. The textural classification of different municipalities located in lowland areas greatly differs from upland areas wherein the former have inherited a dominant loamy texture while the latter varies with three textural properties of sandy clay loam, sandy loam, and silt loam.

Table 1. Classification of texture in Samar.

Location	Sample Sites	Land Condition	Percentage (%)			Textural Class
			Sand	Silt	Clay	
Matuginao	Del Rosario	Upland	58.82	26.47	14.71	Sandy Loam
	San Isidro	Upland	62.07	20.69	17.24	Sandy Loam
	Barus	Upland	60.98	24.39	14.63	Sandy Loam
Gandara	Pessaro	Upland	35.00	50.00	15.00	Silt Loam
	San Agustin	Lowland	35.71	57.14	7.14	Silt Loam
	Diaz	Lowland	45.10	43.14	11.76	Loam
San Jorge	Quezon	Upland	39.47	34.21	26.32	Clay Loam
	Matalud	Upland	68.89	15.56	15.56	Sandy Loam
	Bulao	Lowland	41.38	43.1	15.56	Loam
San Jose de Buan	Hibacaan	Upland	62.79	23.26	13.95	Sandy Loam
	Hiduroma	Upland	64.00	21.00	15.00	Sandy Loam
	Barangay-1	Flat-upland	39.00	43.00	18.00	Loam
Paranas	Tirani	Upland	62.50	26.79	10.71	Sandy Loam
	Tutubigan	Lowland	48.65	29.73	21.62	Loam
	Casandig	Lowland	53.19	36.17	10.64	Loam
Calbiga	Beri	Upland	52.27	25.00	22.27	Sandy Clay Loam
	Hubasan	Upland	55.19	27.66	21.15	Sandy Clay Loam
	Canticum	Lowland	69.00	20.00	11.00	Sandy Loam

Fig. 2. Municipality in the classification of texture in Samar.

3.2 Soil Chemical Properties Status of Crops

The value of chemical properties of soil varies with different topography from municipalities of Samar. The soil pH showed lowland areas municipality have relatively higher pH as compared to upland areas. The percent OM content from different areas have more or less similar classification same as true with the percent N, avail P, exch. Ca, exch. K, exch. Fe, and extra. SO_4. While exchangeable Zn varies accordingly for each site/location. Comparatively, greater deposits of Ca were observed in lowland areas of San Jorge which greatly differs from the rest of the sites.

3.2.1 Municipality of San Jorge

The analyses of chemical properties of soil in San Jorge revealed that there were differences in results taken from different sites as well as inland conditions. The soil pH content from two different sites of Quezon and Matalud obtained the same value of moderately acidic pH ranging from 5.79-5.88 as both sites were located in upland areas. This shows that both sites have acquired ideal soil pH characteristics that are potential for crop growth and development. In contrast, the other site in Brgy. Bulao which was situated in lowland areas has slightly alkaline pH soil (7.48) which showed greater value than the upland site and eventually higher than the ideal soil pH range of 5.5-6.5. This might be attributed to the presence of higher calcium (7,054.35 mg-kg-1) content accumulated in the soil as an indication of higher leaching of this material coming from upland areas especially during heavy rainfall. Meanwhile, in terms of OM content, the sites of Matalud and Bulao have higher OM content than in the Quezon site, as the former was located from remote areas of San Jorge that has more native vegetation that possibly increases the OM content of the soil. The nitrogen level among the three sites was at the medium range (0.11-0.20 percent). However, a very low level of phosphorous (P) was observed in three sites. Potassium (K) level was at optimum in the Bulao site while the low level was observed in both Quezon and Matalud sites which were situated in the upland area. The higher level of K content of the Bulao site could probably due to the higher translocation of mineral leaching that flows towards the lowland areas while the Ca level of all three sites was higher or way beyond the critical level of 300 ppm as it reflects the clayey soil condition of Samar. Besides, the Quezon site has higher iron (Fe) content but it does not indicate plant nutrient toxicity as the other micronutrient such as zinc which was a very low level in all sites in less than 1.6 ppm as the critical level of deficiency. Extractable sulfate was observed to be at the optimum level which was greater than 10 ppm as the critical level of deficiency.

3.1.2 Municipality of Matuginao

Almost all sites of the Municipality of Matuginao are situated in upland areas. Most of their soils have moderately acidic ranging from 4.82-5.95 pH. The nitrogen level of the Del Rosario site has a very high percent nitrogen level (> 0.41%). Thus, N reserves for crop production were at optimum as the majority of their farmers purely employed an organic way of farming. The three sites have almost the same percent OM which was below the desirable OM for better crop yield at 4%. This could be due to the steeper slope farm condition they have where the topsoil was easily leached out during heavy rainfall which also affects phosphorous level to become deficient (< 16 ppm). This shows that upland farming without technology intervention for sloping farming causes soil infertility by having lower pH and deficient in Phosphorous (P) in the long run. Whereas, the potassium (K) concentration was at medium level except for the Barus site. This could probably due to the higher calcium (Ca) content of the said site. Likewise, the Ca level was also higher in all sites, which was greater than 300 ppm, indicating to have an adequate amount for crop growth. The highest Ca content was reflected by the clayey soil condition of Samar. On the other hand, iron (Fe) was at the optimum level except for the site of Del Rosario. However, Zinc (Zn) deficiency was observed in all three sites tested which was less than the critical deficiency level of 1.6 ppm. Furthermore, sulfate content from all sites was at the optimum level (>10 ppm) that was desirable for plant growth and development.

3.1.3 Municipality of Calbiga

Calbiga has moderately acidic to the neutral type of soil ranging from 5.59-7.20 soil pH. The higher soil pH at 7.20 obtained from the Beri site was slightly higher than the ideal soil pH level of 5.5-6.5 for plant growth and development which might be due to the presence of a higher concentration of calcium (Ca) in the said area. The increase of Ca in the soil had simultaneously affected the pH level to increase which turns the soil towards a basic form which could threaten the crops due to nutrient imbalance in the long run. Despite this, important macronutrients such as Potassium (K) and Ca were still sufficient from the area. Comparatively, the lowland area of Calbiga (Canticum site) had lower Ca content than the upland sites which might be the results of the downstream movement of the river present in the area that could reduce the translocation of Ca once irrigated in their farm. In terms of OM content, the Beri site has a higher percent OM content which was closest to the desired level of 4% for potential crop yield. Moreover, a very low range of phosphorous (P) was observed from among two sites (Hubasan and Canticum) was less than 16 ppm. Meanwhile, the Beri site was at the minimum range which might be due to the presence of a higher percent OM content. Furthermore, the micronutrient such as iron (Fe) was at the desired level for the Beri site and very high in two other sites of Hubasan and Canticum. Whereas, zinc (Zn) level was just very low which was less than 1.6 ppm as a critical level for most crops in both upland sites (Beri and Hubasan) at the medium level for lowland sites (Canticum). The very low Zn level for Beri and Hubasan site might be due to the higher Ca level that had influenced the said area. Likewise, the Sulphate level was adequate which was greater than the critical value of deficiency (10 ppm).

3.1.4 Municipality of Paranas

Paranas have a wide range of lowland areas with moderate and slightly acidic soil which was an ideal soil pH level of 5.5 to 6.5 for plant growth and development. Besides, it has a moderate organic matter percentage of at least 2% with a medium to high nitrogen percentage level enough to promote stable nutrient availability to plants. Moreover, one of the sites in the Municipality of Paranas has higher calcium (Ca) concentration which was twice higher than the other two sites (Tirani and Casandig). This might be due to the influence of irrigated water from the river flown over to their field as a source of calcium translocation coming from upland areas. This was an indication that Samar's soil condition has the calcareous type of soil which was leached out mostly downstream to lowland areas. Correspondingly, phosphorous (P) and potassium (K) nutrient levels among all sites were at a very low level which lies lower than 16 ppm and 61 ppm, respectively. This deficiency level of P and K might influence a nutrient imbalance capacity of soil for the whole Municipality. Comparatively, the iron (Fe) level was within (24.1 ppm) and above (57.54 ppm) the range of the optimum level (20 to 30 ppm) as predetermined towards better crop yield. However, Zinc (Zn) content was very lower in both sites (Casandig and Tutubigan) which has less than 1.6 ppm as a critical deficiency level. This could be due to the influence of the higher Ca concentration presence of the soil. Whereas, sulfate content from all sites was adequately available for crop production in which the soil obtained greater than 10 ppm as a critical level of deficiency.

3.1.5 Municipality of Gandara

Regardless of its land condition, the Municipality of Gandara has slightly acidic soil ranging from 5.90- 6.73 soil pH level which was highly sufficient for crop production. It has also moderate percent OM content at an average level of 2.34 % with at least medium to high nitrogen level ranging from 0.13- 0.36 %. This Municipality was highly potential for crop production due to the presence of adequate soil pH, OM, and Nitrogen (N) content but it has very low Phosphorous (P) content which was less than 16 ppm predetermined as a critical deficiency level. Moreover, the Potassium (K) level was also at the lower level. Nevertheless, the calcium (Ca) concentration of the soil was higher which coincides with the results from the other Municipalities tested. While higher iron (Fe) level was observed in two sites (San Agustin and Diaz) which were located in lowland areas. However, a slight difference in Fe content was observed in the upland site of barangay Pessaro compared to the lowland sites. On the contrary, the Zinc (Zn) level from Diaz and Pessaro sites was just very low which was less than 3 ppm considered adequate for most crops. This indicates that the soil was not toxic as the corresponding Zn level was at a lower level even with the presence of higher Fe concentration obtained from three sites.

3.1.6 Municipality of San Jose de Buan

San Jose de Buan has strong to moderately acidic soil ranging from 4.52-5.67 pH. Whereas, organic matter was lower than the desired level of 4%. Nitrogen level was at medium to high nitrogen level. The level of soil OM content obtained by San Jose de Buan was at the minimum level intended for potential crop production. However, upland areas of Hibacaan and Hiduroma sites have lower OM compared to the flat zone upland area. This was mainly due to the soil erosion that mostly occurred from the area where only a few vegetation was present in their upland farm areas leaving the soil uncovered and as a result, OM content present within the topsoil was easily denuded. Due to severe erosion, phosphorous (P) level was at a very low level which is less than 16 ppm as a critical deficiency level for most crops. While potassium (K) level was sporadic to a different site which coincides with the results indicated from calcium (Ca) concentration level. The upland site (Hiduroma) has the highest K concentration which lies above the elevation from the two other sites. Calcareous soil was equally obtained from the upland area (Hibacaan and Hiduroma). While lower Ca concentration was observed in the flat upland area just nearby to the town which might be due to the excessive erosion that causes higher leaching of calcium downstream towards the nearby lowland areas of San Jose de Buan. Whereas, Iron (Fe) concentration of soil varies on the land condition where the upland region of the town (Hibacan and Hiduroma) has a higher Fe concentration (37.26-44.97 ppm). This value was within the range or slightly higher to the optimum range of 20-30 ppm towards potential crop growth as compared in flat zone upland site (Barangay 1) which almost belongs to the critical level of Fe deficiency below 3 ppm. Zinc (Zn) level was very low in all sites which might be associated with the calcareous soil condition in the area. Moreover, extractable sulfate was greater than 10 ppm suited for most crops.

Table 2. Chemical Properties of soil analyses.

Site (Brgy.)	Land Condition	pH (H_2O)	% OM	% Total N	Avail P (mg/kg)	Exchangeable (mg/kg) K	Exchangeable (mg/kg) Ca	Exchangeable (mg/kg) Fe	Exchangeable (mg/kg) Zn	Extr SO4 (mg/kg)
A. San Jorge										
1. Quezon	upland	5.88	1.42	0.17	2.42	69.7	3047.70	116.10	0.53	28.43
2. Matalud	upland	5.79	2.69	0.23	0.88	74.20	3527.90	48.55	0.47	17.09
3. Bulao	lowland	7.48	2.51	0.18	16.00	133.73	7054.35	31.23	0.59	50.96
B. Matuginao										
1. Del Rosario	upland	4.82	1.62	0.83	1.33	97.66	1044.40	15.37	0.21	18.37
2. San Isidro	upland	5.29	1.41	0.15	13.04	99.86	1600.55	63.54	0.64	24.28
3. Barus	upland	5.95	1.75	0.18	10.76	64.09	3943.00	67.34	0.77	22.79
C. Calbiga										
1. Beri	upland	7.20	3.00	0.25	15.12	162.64	5681.75	23.73	0.46	35.26
2. Hubasan	upland	5.59	1.57	0.18	7.19	73.56	3529.35	89.00	0.69	20.91
3. Canticum	lowland	6.42	1.91	0.18	8.12	129.37	2867.50	56.63	2.57	38.73
D. Paranas										
1. Tutubigan	lowland	6.58	2.21	0.19	0.92	54.48	4103.80	24.10	0.48	30.68
2. Tirani	Upland	5.64	2.15	0.20	2.92	45.06	1959.85	57.54	2.59	47.38
3. Casandig	lowland	5.52	1.95	0.40	2.97	42.93	2022.6	40.53	0.70	23.24
E. Gandara										

1. San Agustin	lowland	6.21	3.74	0.36	10.15	69.93	3607.65	150.14	2.27	84.04
2. Diaz	lowland	6.73	1.59	0.13	3.14	52.63	2468.95	112.16	0.68	29.87
3. Pessaro	upland	5.90	1.69	0.16	12.35	68.05	2378.75	96.09	0.63	18.27
F. San Jose de Buan										
1. Hibacaan	upland	5.34	1.72	0.18	9.94	105.48	4100.75	44.97	0.81	15.48
2. Hiduroma	upland	5.67	1.53	0.17	5.46	237.26	5618.65	37.26	0.99	21.50
3. Barangay-1	Flat upland	4.52	2.58	0.23	1.61	44.13	584.65	4.40	0.20	32.87

3.3 Classification of Soil Fertility for Crops

Volcanic ash soil has a higher fertility rate and is more productive for crop growth and development [11], 12]. It is important to determine the physical and chemical properties of soil that are essential in sustaining the nutrient availability for plant uptake. The composition of nutrients may still vary even though it is located in the same place [13]. Therefore, classifying the condition of the soil in a particular area before farming is deemed to be important to enhance the fertility level of the soil and to identify what nutrients are deficient in the area. The results showed that the ideal pH requirements for crop growth were within the range for most of the soil condition in every municipality except for upland sites in San Jose de Buan (Brgy.-1) and Matuginao (Brgy. Del Rosario) with a low probability of fertile soil due to strongly acidic soil (Table 3). However, the pH level of soil both in upland and lowland have fallen under the acidic soil category except for the lowland areas of San Jorge. The percent nitrogen level for most of the sites was moderate with also a moderate level of OM content. However, the amount of P and K were deficient from among all sites evaluated. The widespread deficiency of P and K could be due to the presence of high calcium developed from among the sites inherited by the parent material derived from the sedimentary rock soil condition of Samar. The [14] reported that the build-up of higher calcium in calcareous soil reduces the P availability of soil during precipitation process of insoluble Ca-P phase giving rise to large exchangeable Ca more predominant than P. Deficiency of K as influenced by the excessive amount of calcium in the site as calcium can displace potassium from CEC bind sites leaving it freely in soil solution and leach down to the soil profile especially with high percent sand. Another cause could probably due to the influence of soil that has been heavily cropped and eroded [15] especially in upland areas as Samar (Western Samar) falls under the category of Type IV climate. Lower soil pH experienced from the site could also one of the constraint factors for P and K deficiency. Whereas, micronutrient availability to crop revealed that there was sufficient iron and extractable Sulphate. But zinc was deficient for most of the sample areas. Therefore, the nutrient status of the soil of the study site was low due to the lower amount of available P and K which is essential in the production and development of flowers and fruits of most crops leading to low and declining crop yield. Although the type of soil texture was conducive to farming, there is a need to improve the soil nutrient status in Samar to build a healthy soil-to-crop environment.

Table 3. Characteristics of soil fertility factors for crop.

Soil Fertility Factors	Class		
	High	Moderate	Low
pH (H_2O)	5.5-7.5	5.0-5.5	< 5.0 & > 8
OM (%)	> 3	1-3	< 1
Total N (%)	> 0.25	0.15-0.25	< 0.15
Available P (ppm)	> 35	26-35	< 25
Exchangeable K (mg/kg)	> 250	150-250	< 150
Exchangeable Ca (mg/kg)	> 2,000	1,000-2,000	< 1,000
Exchangeable Fe (mg/kg)	> 5.0	2.5-5.0	< 2.5

Exchangeable Zn (mg/kg)		> 1.5	< 1.0
SO_4	10-20	5-10	<5

Source: BSWM-ELREP, 1985.

4. Conclusions

The lowland agricultural land in Samar has good soil texture relative to upland areas. Generally, it has a deficient amount of P and K which was observed in both upland and lowland areas. Crops suitability measures revealed that lowland areas are more dominant than in the upland areas as the former possessed a noticeable consistent level of loam soil which was observed in different municipalities of Samar. Good management and practices of crop production are deemed important in upland areas to help restore the nutrient and fertility status of the area.

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