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Vegetable Farm Types and Hydromorphic Soil Properties in Ojo Area of Lagos Metropolis, Nigeria

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Abstract

Vegetable cultivation is practiced in cities around the world as urban agriculture aimed at meeting the food and vegetable demand of the urban population. However, like every other human activities it has the potential to cause damage to soil health leading to poor productivity and large environmental impacts. Previous studies on the impact of vegetable cultivation on soil nutrients status have focused on the difference in soil properties of vegetable farms and undisturbed lands. This study examined the impacts of vegetable cultivation under different vegetable farm types in Ojo area of Lagos state, Nigeria. Simple random sampling was used to collect soil samples from the vegetable farms (which were categorized using the dominant vegetable crop grown in each farm). The collected soil samples were analyzed for soil properties (soil pH, Nitrogen, Phosphorous, Potassium, Calcium, Organic Carbon, Sodium, Manganese, Magnesium, Iron etc.) using standard laboratory procedures. The data collected were subjected to descriptive and inferential statistics analysis. The mean and standard deviation was used to show the pattern of distribution as well as Pearson moment correlation to establish the type of association among the soil properties. The results obtained from this analysis revealed that the lettuce farm had the lowest soil pH value at 6.12 while the amaranthus and pumpkin leaf farms had the highest pH value (6.51), organic Carbon, total Nitrogen, Phosphorous and Potassium were lowest in the pumpkin leaf farm (2.014 g/kg, 0.259 g/kg, 0.641 Mg/g and 0.14 Cmol/kg respectively) and highest in the amaranthus farm (6.426 g/kg, 0.649 g/kg, 3.147 Mg/g and 1.23 Cmol/kg respectively), Calcium was lowest in the pumpkin leaf farm (0.25 Cmol/kg) and highest in the spinach farm (1.95 Cmol/kg), Magnesium ranged from 0.31 Cmol/kg in the control to 3.32 Cmol/kg in the spinach farm, Sodium ranged from 0.19 Cmol/kg in the pumpkin leaf farm to 0.41 Cmol/kg in the green onion farm and micronutrients; Manganese, Iron, Copper and Zinc were lowest in the control (3.0 Mg/kg) and highest in the amaranthus farm (137.5 Mg/kg), lowest in the pumpkin leaf (57.2 Mg/kg) and highest in the spinach farm (226.1 Mg/kg), ranged from 2.37 Mg/kg in the control to 4.45 Mg/kg in the spinach farm and ranged from 0.13 Mg/kg in the pumpkin leaf farm to 1.25 Mg/kg in the control respectively. The soil physical and chemical and micronutrient properties as investigated had positive and significant relationship with each other ($P < 0.01$ and $P < 0.05$) under all the vegetable farms studied.

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However, sand of the spinach farm had negative association with silt, clay, saturated hydraulic conductivity and bulk density with ($r = -0.607$, $r = -0.641$, $r = -0.574$ and $r = -0.624$, $P < 0.05$) respectively. Magnesium and organic Carbon of the control also had negative association ($r = -0.034$, $P < 0.05$). The Amaranthus and Scent leaf farms had the highest concentrations in majority of the soil properties while the pumpkin leaf farm had the lowest concentrations of the soil properties. Therefore, the pumpkin leaf vegetable extracts more soil nutrients from the soil than the other vegetable crops. There is need for adequate soil management, more organic matter application and Nitrogen and Potassium should be added in their fertilization programmes in all the vegetable farms especially the pumpkin leaf farm.

Keywords

Vegetable Cultivation, Urban Agriculture, Soil Nutrient Status, Soil Properties

Subject Areas: **Aerography, Atmospheric Sciences, Earth & Environmental Sciences**

1. Introduction

Globally, vegetable cultivation helps in meeting the daily demands for green and leafy vegetables, and in urban areas, it is highly lucrative as a result of the readily available market for the fleshy vegetables as source of household nutrient. Indeed, vegetable cultivation in urban areas increase the access that resident have to fresh fruits and vegetables, providing better nutritional options for city-dwellers and influencing food security. However, according to [1], "vegetable cultivation is an example of intensive agricultural production that has implication on soil physico-chemical properties and the biological productivity of the soil".

According to [2], intensive vegetable farming can result in severe damage to soil structure, soil erosion, reduced soil fertility and the loss of fertilizers and other chemicals from increased runoff and leaching. Also, intensive cultivation of farmlands can lead to deterioration in soil structure and other physical properties of the soil and, consequently, decrease crop yield.

Vegetable cultivation is practiced in cities around the world as urban agriculture aimed at meeting the food and vegetable demand of the urban population. However, like every other human activities it has the potential to cause damage to soil health leading to poor productivity and large environmental impacts. In Ojo Local Government Area of Lagos especially around the LASU perimeter fence, along LASU-Isheri road and along Lagos-Badagry express way, large hectares of land is used particularly for the cultivation of assorted market garden vegetables mainly green leafy vegetables, including lettuce and cabbage and local vegetables such as *Amaranthus candatus*, *Celosis argenntia* and *Corchorous olitorius*.

Vegetable cultivation is an aspect of Urban Agriculture which is said to be the production, processing and distribution of edible agricultural products through intensive plant cultivation and animal husbandry in and around cities [3]. The concepts of ecological disturbance and sustainable land management were adopted. Ecological disturbance is a temporary change in the average environmental conditions that causes a pronounced change in an ecosystem. Vegetable cultivation is an anthropogenic agent of ecological disturbance in that the persistent intensification, specialization and concentration of vegetable production via vegetable cultivation has led to an increase in the use of different types of chemicals such as herbicides, insecticides and fungicides, the use of fertilizers and manure and soil tillage, which contribute significantly to environmental degradation especially land and water degradation. Sustainable land management is defined as a package of technologies applied at all levels of land use, which individually or in aggregate contribute to sustainable agriculture [4]. Sustainable land management is an integral part of the process of harmonizing agriculture and food production with the often conflicting interests of economics and the environment, in that it could serve as an initial step to help farmers in making decisions as to what practices they should use in their fields to maintain or enhance the productive potential of their farms especially the soil nutrients so as to ensure productivity and mitigate land degradation.

Previous studies on the impact of vegetable cultivation on soil nutrients status have focused on the difference in soil properties of vegetable farms and undisturbed lands [5]. The effect of the cultivation of different types of vegetable on soil properties is somewhat novel in literature. Therefore, this research, examined the impacts of vegetable cultivation under different vegetable farm types on soil physical, chemical and micronutrient properties in Ojo area of Lagos State, Nigeria. In order to achieve this, the research further examined the difference in the soil's physical, chemical and micronutrient properties among the different vegetable farm types in the study area; examined the relationship among the properties under different vegetable farm types in the study area; compared the soil properties under different vegetable farm types with those of the control plot in the study area; and suggested better ways of conserving soil nutrient for ecosystem sustainability.

2. Study Area

The study area is located in Ojo Local Government areas of Lagos State which lies between Latitude 6˚42'N and 6˚42'N of the Equator and between Longitude 2˚42'E and 3˚42'E of the Greenwich meridian (**Figure 1**). It is a riverine area. It is bounded in the East and West by Alimosho Local Government Area, in the North by Amuwo-odofin Local Government Area and in the South by Badagry Local Government Area. The area is nearly flat, generally low-lying and close to sea level. This factor combined with the proximity to the sea and heavy annual rainfall averaging 1800 mm has made the area swampy and very prone to water-logging. During the rainy season, the ground water table rises to within a few centimeters slightly above the ground surface. The climate is humid, equatorial with double-peak rainfall regime; the rainy season lasts from March to November. There are rainfalls throughout each month of the year with at least 25 mm of rain falling during the dry season months of January, February and December [5]. The average annual temperature is high, being 26.7˚C with a small annual range of less than 4˚C. The relative humidity of the air is high, rarely falling below 80 percent except in the afternoons.

Since, Ojo LGA is quite close to the coast; hydromorphic soils are prevalent in the area. Water-logging usually occurs when the water table is less than 2 m from the surface [5], and the resulting hydromorphic soils

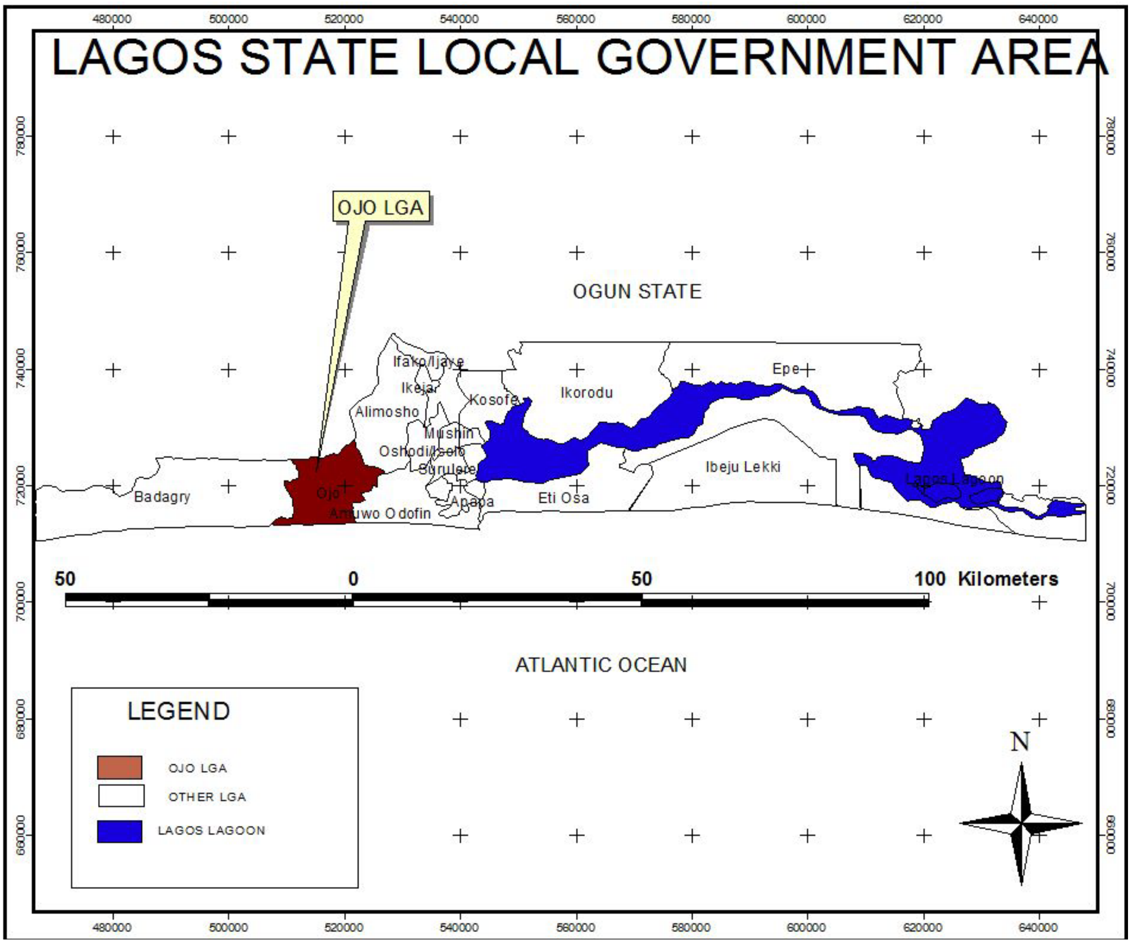

Figure 1. Study area map.

are characterized by poor drainage implying the presence of excess moisture in the soil. The soils in the area according to [5] are sandy being derived partly from sandy marine sediments. The natural vegetation in the area is mainly swamp forest in which raffia palms (*Raphia vinefera* and *Raphia hookeri*) feature permanently. The oil palm (*Elaeis guineensis*) also occurs in the swamps, while *Alchornea cordifolia* is occasionally encountered. Ferns dominate the ground flora of the swamp forest [5].

3. Methodology

A crucial issue in quantitative plant ecology is the determination of the sample frame from which population data are selected. This is because the reliability of the final conclusions depends largely on how well the data have been selected [6]. Multiple subsamples provide a more accurate picture of the entire area and prevent an irregular area from skewing the results. The total area of the vegetable farms is about three and half hectares 2.5 hectares) with different vegetable farm types adjoining one another but were separated by different irregular beds sizes. Random sampling technique was adopted to select ten beds for each vegetable farm type from where 15 soil samples were equally randomly collected for each of the vegetable farm types at the depth of 0 - 15 cm using a soil auger. The 15 samples collected were later bulked to one each for the vegetable farm type. The samples were packaged in polythene bags and sent to the laboratory. According to the oral evidence provided by the operators of the farms, the farms had been in existence for over 20 years. The one control used is as a result of the proximity of the farms to each other and in the same ecological zone. The soil samples were tested for soil pH, total Nitrogen, organic carbon, Phosphorous, Potassium, Sodium, Calcium, Magnesium, Acidity, Manganese, Zinc, Iron, Copper, particle size, bulk density and porosity using standard methods. The data collected were subjected to descriptive and inferential statistics analysis. The mean and standard deviation were used to show the pattern of spatial variation of the soil properties as well as Pearson moment correlation to establish the type of association among the soil properties. In order to determine the extent and presence of the local variation, a control site was chosen to serve as a baseline against which the result of the sampling study is evaluated.

4. Results and Discussion

The descriptive statistics results revealed that, the soil texture has higher values of sand range between 69.7% - 82.9% with mean of 76.3% across different farm types; the silt fraction ranged from 9.7% - 14% with mean of 12.15% and the clay fraction range between 6% - 15.8% with mean of 10.17%; therefore, the dominant textural classes is of loamy sand and sandy loam. The pH of the soils ranged between 6.1 to 6.5 with a mean of 6.4 making the site slightly acidic (**Table 1**). The pH value of the control plot (6.4) is higher than those of the lettuce (6.1), onion (6.38) and spinach (6.25) farms but lower than those of the amaranthus and pumpkin leaf farms which have the same pH values of 6.51 (**Table 1**). The mean value of organic carbon for the control plot (3.34 g/kg) is higher than those of the vegetable farms lettuce farm (5.675 g/kg), onion farm (3.755 g/kg), Spinach farm (5.88 g/kg), amaranthus farm (6.43 g/kg) and pumpkin leaf farm (2.01 g/kg) except that for pumpkin leaf farm which is 2.01 g/kg. The mean values of Total Nitrogen for amaranthus (0.65 g/kg), lettuce (0.59 g/kg), scent leaf (0.58 g/kg) and onion (0.52 g/kg) farms are higher than that of the control (0.47 g/kg); however, the pumpkin leaf farm (0.26 g/kg) is lower than the control's while, the control plot has lower amount of total Nitrogen than the amaranthus (0.65 g/kg), lettuce (0.59 g/kg), scent leaf (0.58 g/kg) and onion (0.52 g/kg) farms (**Table 1**).

The mean Phosphorous (P) of the control is 0.85 mg/g which is lower than those of the lettuce (3.12 Mg/g), spinach (2.92 Mg/g) and amaranthus (3.15 Mg/g), farms but higher than those of the green onion (0.79 Mg/g) and pumpkin leaf (0.64 Mg/g) farms whose Phosphorous values are 0.79 mg/g and 0.64 respectively. The mean calcium value of the control is however lower than the mean calcium values of the lettuce, green onion, scent leaf and amaranthus farms with 1.94 Cmol/kg, 1.25 Cmol/kg, 1.95 Cmol/kg and 1.75 Cmol/kg respectively (**Table 1**). The mean Magnesium value of the control is lower than those of all the vegetable farms with no exception, therefore, the vegetable farms have higher concentration of Magnesium than the control with the mean values 2.97 Cmol/kg, 1.45 Cmol/kg, 3.32 Cmol/kg, 2.63 Cmol/kg and 0.33 Cmol/kg for the lettuce, green onion, spinach, amaranth and pumpkin leaf farms respectively. The Potassium content of the control (0.144 Cmol/kg) is higher than those of the onion, and pumpkin leaf farms which are 0.14 Cmol/kg and 0.14 Cmol/kg respectively but lower than those of the lettuce, scent leaf and amaranthus farms with 0.153 mol/kg, 0.18 Cmol/kg and

Table 1. Laboratory analysis of the soil parameters of the vegetable farms and control.

	Sample Description	pH H_2O	TN g/kg	OC g/kg	P Mg/g	Ca	Mg Cmol / kg	K	Na	Acidity (Cmol/kg)	Mn	Fe Mg/kg	Cu	Zn	(%) sand	(%) silt	(%) clay	Ks (cm/hr)	Bulk Density (g/cm^3)	Porosity (%)
1	Lettuce	6.12	0.587	5.675	3.119	1.939	2.970	0.153	0.385	0.150	106.4	93.0	4.38	0.650	76.0	10.90	12.90	143.90	1.220	54.15
2	Green Onion	6.38	0.521	3.755	0.797	1.250	1.451	0.141	0.410	0.20	47.7	82.2	2.57	0.323	76.7	12.65	10.65	132.55	1.360	48.70
3	Spinach	6.25	0.583	5.881	2.915	1.945	3.324	0.177	0.403	0.225	106.3	226.1	4.45	0.435	69.7	13.55	8.25	150.75	1.195	54.90
4	Amaranthus	6.51	0.649	6.426	3.147	1.749	2.634	1.231	0.403	0.150	137.5	177.7	4.26	0.425	70.2	14.0	15.80	149.25	1.185	55.30
5	Pumpkin leaf	6.51	0.259	2.014	0.641	0.253	0.328	0.139	0.185	0.175	4.55	57.2	2.95	0.130	82.9	9.70	7.40	114.40	1.49	43.75
6	Control	6.43	0.467	3.336	0.845	0.558	0.304	0.144	0.341	0.150	3.0	208	2.37	1.250	81.9	12.10	6.0	110.10	1.54	41.85

1.23 Cmol/kg, respectively (**Table 1**). Sodium value of the control plot with 0.34 Cmol/kg is higher than those of lettuce farm, onion farm, Spinach farm and amaranthus farm with mean values of 0.39 Cmol/kg, 0.41 Cmol/kg, 0.40 Cmol/kg, 1.23 Cmol/kg, respectively except that of the pumpkin leaf farm with 0.19 Cmol/kg.

The control plot has the same level of acidity (0.15) as the Lettuce and Amaranthus farms but has lower acidity than the Green onion farm (0.20), Spinach farm (0.225) and the Pumpkin leaf farm (0.18). Iron (Fe) value of the control (208 Mg/kg) is higher than those of the vegetable farms (lettuce farm with 93 Mg/kg, onion farm with 82.2 Mg/kg, amaranthus farm with 177.7 Mg/kg and pumpkin leaf farm with 57.2 Mg/kg; except that of the Spinach farm with 226.1 Mg/kg. Manganese (Mn) value of the control is lower than those lettuce farm with 106.4 Mg/kg, onion farm with 47.7 Mg/kg, Spinach farm with 106.3 Mg/kg, amaranthus farm with 137.5 Mg/kg and pumpkin leaf farm with 4.55 Mg/kg. Copper value of the control plot of 2.37 Mg/kg is lower than those of lettuce farm with 4.38 Mg/kg, onion farm with 2.57 Mg/kg, Spinach farm with 4.45 Mg/kg, amaranthus farm with 4.26 Mg/kg and pumpkin leaf farm with 2.95 Mg/kg. While the Zinc value of the control with 1.25 Mg/kg is higher than those of all the vegetable farms with lettuce farm with 0.65 Mg/kg, onion farm with 0.323 Mg/kg, Spinach farm with 0.435 Mg/kg, amaranthus farm with 0.425 Mg/kg and pumpkin leaf farm with 0.13 Mg/kg (**Table 1**).

The control has the lowest Saturated Hydraulic conductivity with 110.10 cm/hr compared to the Spinach farm with 150.75 cm/h which has the highest saturated hydraulic conductivity followed by amaranthus farm with 149.25 cm/hr, lettuce farm with 143.90 cm/hr, green onion farm with 143.90 cm/hr and the pumpkin leaf farm with 114.40 cm/hr. The control plot has the highest Bulk Density of 1.54 g/cm³, compared to the pumpkin leaf farm with 1.49 g/cm³ followed by the green onion farm with 1.360 g/cm³, the lettuce farm with 1.220 g/cm³, the Spinach farm with 1.195 g/cm³ and the amaranthus farm which has the lowest bulk density with 1.185 g/cm³. The Amaranthus farm has the highest porosity with 55.3% followed by the Spinach farm with porosity of 54.9%, the lettuce farm with porosity of 54.15%, the green onion farm with porosity with 48.7%, the pumpkin leaf farm with 43.75% and the control plot which has the lowest porosity at 41.85% (**Table 1**).

In terms of the relationship among the nutrients in the lettuce farm, there is positive and significant relationship between silt and sand ($r = 0.992$, $P < 0.01$); clay with sand and silt ($r = 0.995$, $r = 0.994$, $P < 0.01$) respectively; saturated hydraulic conductivity with sand, silt and clay had significant association with ($r = 0.994$, $r = 0.993$, $r = 0.996$, $P < 0.01$) respectively; bulk density had significant association with sand, silt, clay and saturated hydraulic conductivity with ($r = 0.995$, $r = 0.996$, $r = 0.999$ and $r = 0.997$, $P < 0.01$) respectively; while porosity significantly associated with sand, silt, clay, saturated hydraulic conductivity and bulk density with ($r = 0.996$, $r = 0.994$, $r = 0.995$, $r = 0.997$, and $r = 0.995$, $P < 0.01$), respectively (**Table 2**).

Also, the soil pH had significant association with total Nitrogen ($r = 0.996$, $P < 0.01$), organic Carbon with pH and total Nitrogen ($r = 0.997$ and $r = 0.995$, $P < 0.01$), respectively; Phosphorous with pH, total Nitrogen and organic Carbon with ($r = 0.988$, $r = 0.990$ and $r = 0.990$, $P < 0.01$) respectively; Calcium with pH, total Nitrogen, organic Carbon and Phosphorous ($r = 0.995$, $r = 0.996$, $r = 0.996$ and $r = 0.994$, $P < 0.01$) respectively; Magnesium with pH, total Nitrogen, organic Carbon, Phosphorous and Calcium with ($r = 0.926$, $r = 0.919$, $r = 0.921$, $r = 0.877$ and $r = 0.903$, $P < 0.01$) respectively; Potassium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium and Magnesium ($r = 0.994$, $r = 0.997$, $r = 0.998$, $r = 0.993$, $r = 0.997$ and $r = 0.911$, $P < 0.01$) respectively; Sodium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Magnesium and Potassium with ($r = 0.998$, $r = 0.998$, $r = 0.997$, $r = 0.989$, $r = 0.997$, $r = 0.923$ and $r = 0.997$, $P < 0.01$) respectively while Acidity associated significantly with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Magnesium, Potassium and Sodium ($r = 0.993$, $r = 0.997$, $r = 0.995$, $r = 0.994$, $r = 0.999$, $r = 0.903$, $r = 0.998$ and $r = 0.996$, $P < 0.01$), respectively (**Table 3**). Also, iron and Manganese ($r = 0.988$, $P < 0.01$), Copper with Manganese and Iron ($r = 0.985$ and $r = 0.997$, $P < 0.01$ respectively) and Zinc with Manganese, Iron and Copper ($r = 0.985$, $r = 0.994$ and $r = 0.991$, $P < 0.01$) respectively (**Table 4**).

In the Green onion farm, the silt had significant association with sand ($r = 0.981$, $P < 0.01$), clay with sand and silt ($r = 0.989$ and $r = 0.994$, $P < 0.01$) respectively; saturated hydraulic conductivity with sand, silt and clay ($r = 0.990$, $r = 0.994$ and $r = 0.997$, $P < 0.01$) respectively; bulk density with sand, silt, clay and saturated hydraulic conductivity ($r = 0.994$, $r = 0.993$, $r = 0.995$ and $r = 0.997$, $P < 0.01$) respectively; and porosity had positive significant association with sand, silt, clay, saturated hydraulic conductivity and bulk density ($r = 0.995$, $r = 0.989$, $r = 0.990$, $r = 0.994$ and $r = 0.999$, $P < 0.01$), respectively (**Table 5**); Organic Carbon and pH ($r = 0.995$, $P < 0.01$), Phosphorous with pH and organic Carbon ($r = 0.816$ and $r = 0.786$, $P < 0.01$) respectively; Calcium with pH, organic Carbon and Phosphorous ($r = 0.990$, $r = 0.989$ and $r = 0.840$, $P < 0.01$) respectively; Magne-

Table 2. Correlation Matrix of the soil physical properties of the lettuce farm.

Vegetable Farm Type	Soil Physical Properties		Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Lettuce Farm	Sand (%)	Pearson Correlation						
	Silt (%)	Pearson Correlation	0.992^{**}					
	Clay (%)	Pearson Correlation	0.995^{**}	0.994^{**}				
	Ks (Cm/hr)	Pearson Correlation	0.994^{**}	0.993^{**}	0.996^{**}			
	Bulk Density (g/cm³)	Pearson Correlation	0.995^{**}	0.996^{**}	0.999^{**}	0.997^{**}		
	Porosity (%)	Pearson Correlation	0.996^{**}	0.994^{**}	0.995^{**}	0.997^{**}	0.995^{**}	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 3. Correlation matrix of the soil chemical properties of the lettuce farm.

Vegetable Farm Type	Soil Chemical Properties		pH (H_2O)	TN g/kg	OC g/kg	P Mg/g	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Na Cmol/kg	Acidity Cmol/kg
Lettuce Farm	pH (H_2O)	Pearson Correlation									
	TN (g/kg)	Pearson Correlation	0.996^{**}								
	OC (g/kg)	Pearson Correlation	0.997^{**}	0.995^{**}							
	P (Mg/g)	Pearson Correlation	0.988^{**}	0.990^{**}	0.990^{**}						
	Ca (Cmol/kg)	Pearson Correlation	0.995^{**}	0.996^{**}	0.996^{**}	0.994^{**}					
	Mg (Cmol/kg)	Pearson Correlation	0.926^{**}	0.919^{**}	0.921^{**}	0.877^{**}	0.903^{**}				
	K (Cmol/kg)	Pearson Correlation	0.994^{**}	0.997^{**}	0.998^{**}	0.993^{**}	0.997^{**}	0.911^{**}			
	Na (Cmol/kg)	Pearson Correlation	0.998^{**}	0.998^{**}	0.997^{**}	0.989^{**}	0.997^{**}	0.923^{**}	0.997^{**}		
	Acidity (Cmol/kg)	Pearson Correlation	0.993^{**}	0.997^{**}	0.995^{**}	0.994^{**}	0.999^{**}	0.903^{**}	0.998^{**}	0.996^{**}	

**Correlation is significant at the 0.01 level (2-tailed). Source: Field work, August 2013.

Table 4. Correlation Matrix of the soil micronutrients of the lettuce farm.

Vegetable Farm Type	Soil Micronutrients		Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Lettuce Farm	Mn (Mg/kg)	Pearson Correlation				
	Fe (Mg/kg)	Pearson Correlation	0.988^{**}			
	Cu (Mg/kg)	Pearson Correlation	0.985^{**}	0.997^{**}		
	Zn (Mg/kg)	Pearson Correlation	0.985^{**}	0.994^{**}	0.991^{**}	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 5. Correlation Matrix of the soil physical properties of the green onion farm.

Vegetable Farm Type	Soil physical properties	Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Green Onion Farm	Sand (%)						
	Silt (%)	0.981**					
	Clay (%)	0.989**	0.994**				
	Ks (Cm/hr)	0.990**	0.994**	0.997**			
	Bulk Density (g/cm³)	0.994**	0.993**	0.995**	0.997**		
	Porosity (%)	0.995**	0.989**	0.990**	0.994**	0.999**	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

sium with pH, organic Carbon, Calcium and Phosphorous (r = 0.747, r = 0.768 and r = 0.768, P < 0.01 and r = 0.624, P < 0.05) respectively; Potassium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium and Magnesium (r = 0.998, r = 0.995, r = 0.794, r = 0.984 and r = 0.757, P < 0.01) respectively; Sodium with pH, organic Carbon, Phosphorous, Calcium, Magnesium and Potassium (r = 0.992, r = 0.995, r = 0.745, r = 0.977, r = 0.742 and r = 0.995, P < 0.01) respectively; and Acidity had positive and significant relationship with pH, organic Carbon, Phosphorous, Calcium, Magnesium, Potassium and Sodium (r = 0.993, r = 0.993, r = 0.805, r = 0.985, r = 0.735, r = 0.991 and r = 0.988, P < 0.01), respectively (**Table 6**). Positive and significant relationship existed between Iron and Manganese (r = 0.986, P < 0.01), Copper with Manganese and Iron (r = 0.992 and r = 0.989, P < 0.01) respectively and Zinc with Manganese, Iron and Zinc (r = 0.995, r = 0.990 and r = 0.996, P < 0.01), respectively (**Table 7**).

There is positive and significant association among the soil properties of the spinach farm as follows: clay and silt (r = 0.987, P < 0.01), saturated hydraulic conductivity with silt and clay (r = 0.997 and r = 0.986, P < 0.01) respectively; bulk density with silt, clay and saturated hydraulic conductivity (r = 0.997, r = 0.991 and r = 0.993, P < 0.01) respectively and porosity with silt, clay, saturated hydraulic conductivity and bulk density (r = 0.905, r = 0.902, r = 0.907 and r = 0.889, P < 0.01), respectively (**Table 8**). Total Nitrogen and pH (r = 0.997, P < 0.01); organic Carbon with pH and total Nitrogen (r = 0.993 and r = 0.996, P < 0.01) respectively; Phosphorous with pH, total Nitrogen and organic Carbon (r = 0.630, r = 0.593 and r = 0.598, P < 0.05), respectively); Calcium with pH, total Nitrogen, organic Carbon and Phosphorous (r = 0.995, r = 0.998 and r = 0.995, P < 0.01 and r = 0.577, P < 0.05), respectively; Magnesium with pH, total Nitrogen, organic carbon, calcium and Phosphorous (r = 0.998, r = 0.992, r = 0.987 and r = 0.990 and r = 0.658, P < 0.05) respectively; Potassium with pH, total Nitrogen, Potassium, Calcium and Magnesium (r = 0.990, r = 0.984, r = 0.983, r = 0.692, r = 0.979 and r = 0.992, P < 0.01) respectively; Sodium with pH, total Nitrogen, organic carbon, calcium, Magnesium, Potassium and Phosphorous (r = 0.992, r = 0.995, r = 0.994, r = 0.995, r = 0.986 and r = 0.971, P < 0.01 and r = 0.579, P < 0.05) respectively; and Acidity with pH, total Nitrogen, organic Carbon, Calcium, Magnesium, Potassium, Sodium and Phosphorous (r = 0.996, r = 0.994, r = 0.988, r = 0.989, r = 0.996, r = 0.994 and r = 0.982, P < 0.01 and 0.643, P < 0.05), respectively (**Table 9**). Iron and Manganese (r = 0.981, P < 0.01), Copper with Manganese and Iron (r = 0.984 and r = 0.973, P < 0.01) respectively and Zinc with Manganese, Iron and Copper (r = 0.988, r = 0.987 and r = 0.988, P < 0.01) respectively. But sand had positive and significant relationship with silt, clay, saturated hydraulic conductivity and bulk density (r = −0.607, r = −0.641, r = −0.574 and –r = 0.624, P < 0.05), respectively (**Table 10**).

There is positive and significant relationship among the soil properties in the amaranthus farm as follows: silt and sand (r = 0.991, P < 0.01), clay with sand and silt (r = 0.989 and r = 0.997, P < 0.01) respectively; saturated hydraulic conductivity with sand, silt and clay (r = 0.993, r = 0.996 and r = 0.996, P < 0.01) respectively; bulk density with sand, silt, clay and saturated hydraulic conductivity (r = 0.991, r = 0.995, r = 0.989 and r = 0.993, P < 0.01) respectively; and porosity with sand, silt, clay, saturated hydraulic conductivity and bulk density (r = 0.984, r = 0.995, r = 0.998, r = 0.994, and r = 0.991, P < 0.01), respectively (**Table 11**). pH and total Nitrogen (r

Table 6. Correlation Matrix of the soil chemical properties of the Green onion farm.

Soil Chemical Properties	pH (H_2O)	TN g/kg	OC g/kg	P Mg/g	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Na Cmol/kg
pH (H_2O)								
TN (g/kg)	0.235							
OC (g/kg)	0.995**	0.223						
P (Mg/g)	0.816**	0.082	0.786**					
Ca (Cmol/kg)	0.990**	0.249	0.989**	0.840**				
Mg (Cmol/kg)	0.747**	0.226	0.768**	0.624*	0.768**			
K (Cmol/kg)	0.998**	0.223	0.995**	0.794**	0.984**	0.757**		
Na (Cmol/kg)	0.992**	0.248	0.995**	0.745**	0.977**	0.742**	0.995**	
Acidity (Cmol/kg)	0.993**	0.197	0.993**	0.805**	0.985**	0.735**	0.991**	0.988**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 7. Correlation Matrix of the soil micronutrients of the green onion farm.

Vegetable Farm Type	Soil Micronutrients	Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Green Onion Farm	Mn (Mg/k)				
	Fe (Mg/k)	0.986**			
	Cu (Mg/kg)	0.992**	0.989**		
	Zn (Mg/kg)	0.995**	0.990**	0.996**	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 8. Correlation Matrix of the soil physical properties of the Spinach farm.

Vegetable Farm Type	Soil Physical Properties	Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Spinach Farm	Sand (%)						
	Silt (%)	−0.607*					
	Clay (%)	−0.641*	0.987**				
	Ks (Cm/hr)	−0.574*	0.997**	0.986**			
	Bulk Density (g/cm³)	−0.624*	0.997**	0.991**	0.993**		
	Porosity (%)	−0.550	0.905**	0.902**	0.907**	0.889**	

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 9. Correlation Matrix of the soil chemical properties of the spinach farm.

Vegetable Farm Type	Soil Chemical Properties	pH (H_2O)	TN (g/kg)	OC (g/kg)	P (Mg/g)	Ca (Cmol/kg)	Mg (Cmol/kg)	K (Cmol/kg)	Na (Cmol/kg)	Acidity
Spinach Farm	pH (H_2O)	1								
	TN (g/kg)	0.997**	1							
	OC (g/kg)	0.993**	0.996**	1						
	P (Mg/g)	0.630*	0.593*	0.598*	1					
	Ca (Cmol/kg)	0.995**	0.998**	0.995**	0.577*	1				
	Mg (Cmol/kg)	0.998**	0.992**	0.987**	0.658*	0.990**	1			
	K (Cmol/kg)	0.990**	0.984**	0.983**	0.692**	0.979**	0.992**	1		
	Na (Cmol/kg)	0.992**	0.995**	0.994**	0.579*	0.995**	0.986**	0.971**	1	
	Acidity	0.996**	0.994**	0.988**	0.643*	0.989**	0.996**	0.994**	0.982**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 10. Correlation Matrix of the soil micronutrients of the Spinach farm.

Vegetable Farm Type	Soil Micronutrients	Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Spinach Farm	Mn (Mg/kg)	1			
	Fe (Mg/kg)	0.981**	1		
	Cu (Mg/kg)	0.984**	0.973**	1	
	Zn (Mg/kg)	0.988**	0.987**	0.988**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 11. Correlation Matrix of the soil physical properties of the amaranthus farm.

Vegetable Farm Type	Soil Physical Properties		Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Amaranthus Farm	Sand (%)	Pearson Correlation	1					
	Silt (%)	Pearson Correlation	0.991**	1				
	Clay (%)	Pearson Correlation	0.989**	0.997**	1			
	Ks (Cm/hr)	Pearson Correlation	0.993**	0.996**	0.996**	1		
	Bulk Density (g/cm³)	Pearson Correlation	0.991**	0.995**	0.989**	0.993**	1	
	Porosity (%)	Pearson Correlation	0.984**	0.995**	0.998**	0.994**	0.991**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

= 0.998, P < 0.01), organic Carbon with pH and total Nitrogen (r = 0.995 and r = 0.994, P < 0.01) respectively; Phosphorous with pH, total Nitrogen and organic Carbon (r = 0.994, r = 0.995 and r = 0.996, P < 0.01) respectively; Calcium with pH, total Nitrogen, organic Carbon and Phosphorous (r = 0.998, 0.997, 0.995 and 0.996, P < 0.01) respectively; Magnesium with pH, total Nitrogen, organic Carbon, Phosphorous and Calcium (r = 0.839, r = 0.842, r = 0.807, r = 0.812 and r = 0.829, P < 0.01) respectively; Potassium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium and Magnesium (r = 0.995, r = 0.995, r = 0.998, r = 0.996, r = 0.993 and r = 0.830, P < 0.01) respectively; Sodium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Magnesium and Potassium (r = 0.996, r = 0.996, r = 0.994, r = 0.993, r = 0.994, r = 0.851 and r = 0.996, P < 0.01) respectively; and Acidity with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Magnesium, Potassium and Sodium (r = 0.999, r = 0.996, r = 0.994, r = 0.993, r = 0.997, r = 0.841, r = 0.994 and r = 0.996, P < 0.01), respectively (**Table 12**). Iron and Manganese (r = 0.992, P < 0.01), Copper with Manganese and Iron (r = 0.993 and r = 0.992, P < 0.01) respectively and Zinc with Manganese, Iron and Copper (r = 0.993, r = 0.995 and r = 0.997, P < 0.01), respectively (**Table 13**).

There is positive and significant relationship among the soil properties in the pumpkin leaf farm as follows: silt and sand (r = 0.998, P < 0.01), clay with sand and silt (r = 0.998 and r = 0.994, P < 0.01) respectively; saturated hydraulic conductivity with sand, silt and clay (r = 0.995, r = 0.992 and r = 0.997, P < 0.01) respectively; bulk density with sand, silt, clay and saturated hydraulic conductivity (r = 0.995, r = 0.991, r = 0.997 and r = 0.994, P < 0.01 respectively) and porosity with sand, silt, clay, saturated hydraulic conductivity and bulk density (r = 0.994, r = 0.990, r = 0.995, r = 0.995, and r = 0.996, P < 0.01), respectively (**Table 14**). pH and total Nitrogen (r = 0.996, P < 0.01), organic Carbon with pH and total Nitrogen (r = 0.996 and r = 0.994, P < 0.01) respectively; Phosphorous with pH, total Nitrogen and organic Carbon (r = 0.981, r = 0.977 and r = 0.982, P < 0.01) respectively; Calcium with pH, total Nitrogen, organic Carbon and Phosphorous (r = 0.988, r = 0.993, r = 0.987 and r = 0.955, P < 0.01) respectively; Magnesium with pH, total Nitrogen, organic Carbon, Phosphorous and Calcium (r = 0.953, r = 0.960, r = 0.952, r = 0.939 and r = 0.945, P < 0.01) respectively); Potassium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium and Magnesium (r = 0.995, 0.995, 0.995, 0.975, 0.995 and 0.950, P < 0.01) respectively), Sodium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium,

Table 12. Correlation Matrix of the soil chemical properties of the amaranthus farm.

Vegetable Farm Type	Soil Chemical Properties		pH (H_2O)	TN g/kg	OC g/kg	P Mg/g	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Na Cmol/kg	Acidity Cmol/kg
Amaranthus Farm	pH (H_2O)	Pearson Correlation	1								
	TN (g/kg)	Pearson Correlation	0.998**	1							
	OC (g/kg)	Pearson Correlation	0.995**	0.994**	1						
	P (Mg/g)	Pearson Correlation	0.994**	0.995**	0.996**	1					
	Ca (Cmol/kg)	Pearson Correlation	0.998**	0.997**	0.995**	0.996**	1				
	Mg (Cmol/kg)	Pearson Correlation	0.839**	0.842**	0.807**	0.812**	0.829**	1			
	K (Cmol/kg)	Pearson Correlation	0.995**	0.995**	0.998**	0.996**	0.993**	0.830**	1		
	Na (Cmol/kg)	Pearson Correlation	0.996**	0.996**	0.994**	0.993**	0.994**	0.851**	0.996**	1	
	Acidity (Cmol/kg)	Pearson Correlation	0.999**	0.996**	0.994**	0.993**	0.997**	0.841**	0.994**	0.996**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 13. Correlation Matrix of the soil micronutrients of the amaranthus farm.

Vegetable Farm Type	Soil Micronutrients	Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Amaranthus Farm	Mn (Mg/kg)	1			
	Fe (Mg/kg)	0.992**	1		
	Cu (Mg/kg)	0.993**	0.992**	1	
	Zn (Mg/kg)	0.993**	0.995**	0.997**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 14. Correlation Matrix of the soil physical properties of the pumpkin leaf farm.

Vegetable Farm Type	Soil Physical Properties	Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Pumpkin leaf farm	Sand (%)	1					
	Silt (%)	0.998**	1				
	Clay (%)	0.998**	0.994**	1			
	Ks (Cm/hr)	0.995**	0.992**	0.997**	1		
	Bulk Density (g/cm³)	0.995**	0.991**	0.997**	0.994**	1	
	Porosity (%)	0.994**	0.990**	0.995**	0.995**	0.996**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Magnesium and Potassium (r = 0.996, 0.993, 0.997, 0.970, 0.992, 0.947 and 0.995, P < 0.01 respectively) and Acidity with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Magnesium, Potassium and Sodium (r = 0.992, 0.992, 0.990, 0.988, 0.974, 0.959, 0.986 and 0.984, P < 0.01), respectively (**Table 15**). Iron and Manganese (r = 0.980, P < 0.01), Copper with Manganese and Iron (r = 0.994 and 0.979, P < 0.01 respectively) and Zinc with Manganese, Iron and Copper (r = 0.977, 0.996 and 0.982, P < 0.01), respectively (**Table 16**).

Table 15. Correlation Matrix of the soil chemical properties of the pumpkin leaf farm.

Vegetable Farm Type	Soil Chemical Properties	pH (H_2O)	TN g/kg	OC g/kg	P Mg/g	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Na Cmol/kg	Acidity Cmol/kg
Pumpkin leaf Farm	pH (H_2O)	1								
	TN (g/kg)	0.996**	1							
	OC (g/kg)	0.996**	0.994**	1						
	P (Mg/g)	0.981**	0.977**	0.982**	1					
	Ca (Cmol/kg)	0.988**	0.993**	0.987**	0.955**	1				
	Mg (Cmol/kg)	0.953**	0.960**	0.952**	0.939**	0.945**	1			
	K (Cmol/kg)	0.995**	0.995**	0.995**	0.975**	0.995**	0.950**	1		
	Na (Cmol/kg)	0.995**	0.993**	0.997**	0.970**	0.992**	0.947**	0.995**	1	
	Acidity (Cmol/kg)	0.992**	0.992**	0.990**	0.988**	0.974**	0.959**	0.986**	0.984**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 16. Correlation Matrix of the soil micronutrients of the pumpkin leaf farm.

Vegetable Farm Type	Soil Micronutrients	Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Pumpkin leaf Farm	Mn (Mg/kg)	1			
	Fe (Mg/kg)	0.980**	1		
	Cu (Mg/kg)	0.994**	0.979**	1	
	Zn (Mg/kg)	0.977**	0.996**	0.982**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

There is positive and significant relationship among the soil properties in the control plot as follows: clay and silt ($r = 0.995$, $P < 0.01$), saturated hydraulic conductivity with sand and clay ($r = 0.997$ and 0.995, $P < 0.01$ respectively), bulk density with sand, clay and saturated hydraulic conductivity ($r = 0.995$, 0.992 and 0.996, $P < 0.01$ respectively) and porosity with sand, clay, saturated hydraulic conductivity and bulk density ($r = 0.997$, 0.996, 0.997 and 0.994, $P < 0.01$), respectively (**Table 17**). pH and total Nitrogen ($r = 0.962$, $P < 0.01$), organic Carbon with pH and total Nitrogen ($r = 0.996$ and 0.992, $P < 0.01$ respectively), Phosphorous with pH, total Nitrogen and organic Carbon ($r = 0.996$, 0.976 and 0.993, $P < 0.01$), respectively; Calcium with pH, total Nitrogen, organic Carbon and Phosphorous ($r = 0.994$, 0.977, 0.995 and 0.997, $P < 0.01$ respectively), Potassium with pH, total Nitrogen, organic Carbon, Phosphorous and Calcium ($r = 0.999$, 0.961, 0.995, 0.995 and 0.992, $P < 0.01$), respectively; Sodium with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium and Potassium ($r = 0.997$, 0.968, 0.995, 0.996, 0.995 and 0.997, $P < 0.01$ respectively) and Acidity with pH, total Nitrogen, organic Carbon, Phosphorous, Calcium, Potassium and Sodium ($r = 0.994$, 0.964, 0.994, 0.996, 0.996, 0.993 and 0.996, $P < 0.01$), respectively (**Table 18**). Iron and Manganese ($r = 0.996$, $P < 0.01$), Copper with Manganese and Iron ($r = 0.997$ and 0.989, $P < 0.01$ respectively) and Zinc with Manganese, Iron and Copper ($r = 0.992$, 0.988 and 0.996, $P < 0.01$), respectively (**Table 19**).

5. Conclusions

Results from the study indicate that the soils were generally sandy loam to loamy sand in texture, slightly acidic (6.12 - 6.51) and medium to high contents of Organic Carbon for all vegetable farms with the green onion and pumpkin leaf farms have moderate contents of Organic Carbon while the lettuce, scent leaf and amaranth farms

Table 17. Correlation Matrix of the soil physical properties of the control plot.

Vegetable Farm Type	Soil Physical Properties	Sand (%)	Silt (%)	Clay (%)	Ks (Cm/hr)	Bulk Density (g/cm³)	Porosity (%)
Control plot	Sand (%)	1					
	Silt (%)	0.409	1				
	Clay (%)	0.995**	0.442	1			
	Ks (Cm/hr)	0.997**	0.442	0.995**	1		
	Bulk Density (g/cm³)	0.995**	0.422	0.992**	0.996**	1	
	Porosity (%)	0.997**	0.446	0.996**	0.997**	0.994**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 18. Correlation Matrix of the soil chemical properties of the control plot.

Vegetable Farm Type	Soil Chemical Properties	pH (H20)	TN g/kg	OC g/kg	P Mg/g	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Na Cmol/kg	Acidity Cmol/kg
Control Plot	pH (H20)	1								
	TN (g/kg)	0.962**	1							
	OC (g/kg)	0.996**	0.962**	1						
	P (Mg/g)	0.996**	0.976**	0.993**	1					
	Ca (Cmol/kg)	0.994**	0.977**	0.995**	0.997**	1				
	Mg (Cmol/kg)	0.017	0.106	-0.034	0.052	0.019	1			
	K (Cmol/kg)	0.999**	0.961**	0.995**	0.995**	0.992**	0.001	1		
	Na (Cmol/kg)	0.997**	0.968**	0.995**	0.996**	0.995**	0.018	0.997**	1	
	Acidity (Cmol/kg)	0.994**	0.964**	0.994**	0.996**	0.996**	0.043	0.993**	0.996**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

Table 19. Correlation Matrix of the soil micronutrients of the control plot.

Vegetable Farm type	Soil Micronutrients	Mn (Mg/kg)	Fe (Mg/kg)	Cu (Mg/kg)	Zn (Mg/kg)
Control Plot	Mn (Mg/kg)	1			
	Fe (Mg/kg)	0.996**	1		
	Cu (Mg/kg)	0.997**	0.989**	1	
	Zn (Mg/kg)	0.992**	0.988**	0.996**	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Source: Field work, August 2013.

have adequate Organic Carbon contents. The control has Organic Carbon contents of 3.336 g/kg indicating (medium) moderate amount of OC. Worthy of note is that the soils of all the farms and the control contained total Nitrogen and Phosphorous below and above the critical limits for crop production respectively and categorized as low (Nitrogen) and high (Phosphorous), therefore all the locations sampled in the study are deficient in total Nitrogen but have adequate amount of Phosphorous which is attributed to the application of inorganic Phosphate fertilizers. The deficiency in Nitrogen could be attributed to leaching or runoff.

With low to high contents of exchangeable bases: Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na); Calcium was generally deficient in all the locations, Magnesium was deficient in the control and pumpkin leaf farm, moderate in the lettuce, green onion and amaranth farms and adequate in the scent leaf farm. Potassium was low and deficient in all the farms and the control except the amaranth farm and Sodium contents were moderate in the control and the lettuce, scent leaf, green onion and amaranthus farms but low in the pumpkin leaf farm. Zinc contents were generally low in all the vegetable farms but moderate in the control. Copper and Iron contents were generally adequate in all the locations; the vegetable farms and control inclusive. Manganese contents were high in all the vegetable farms except the pumpkin leaf farm which has moderate Mn contents as the control; implying that the soils are not improvished as a result of the judicious application of both organic and inorganic fertilizers.

When compared in terms of the elements' range value categories with the vegetable farms; the control differed in Organic Carbon contents from the lettuce, scent leaf and amaranthus farms, differed in Magnesium contents with the scent leaf farm, in Potassium contents with amaranth farm, in Sodium with the pumpkin leaf farm, in Zinc with all the vegetable farms and in Manganese contents with all the vegetable farms except the pumpkin leaf farm. The vegetable farms had moderate Magnesium and Sodium and most of the farms were deficient in Calcium, Total Nitrogen, Zinc and Potassium. All the locations were deficient in Total Nitrogen and Calcium and have adequate Phosphorous, Copper, Manganese and Iron.

6. Summary

The soils were coarse textured giving the dominant textural classes as sandy loam and loamy sand for all the vegetable farms and loamy sand for the control. Owing to the sandy nature of the soils of the vegetable farms and control plots had high bulk density, saturated hydraulic conductivity and porosity. The pH of the soils studied ranged from 6.12 to 6.51 with mean of 6.34 across the vegetable farms and that of the control at 6.43 indicating slightly acidic pH range class. Organic Carbon of the vegetable farms' and the control plot's soils were low. Total Nitrogen of the vegetable farms ranged from 0.259 g/kg to 0.649 g/kg with a mean of 0.52 g/kg and that of the control was 0.467 g/kg. Therefore, both the vegetable farms and the control had low Total Nitrogen values because the values fell below the medium range value of 1.0 g/kg - 4.5 g/kg as stated by [7]. Available Phosphorous of the vegetable farms' soils ranged from 0.641 mg/g to 3.147 mg/g with a mean of 2.124 mg/g and that of the control was 0.845 mg/g indicating that the vegetable farms' and the control's soils had adequate Phosphorous contents in the soil.

The vegetable farms' and the control plot's soils had low Calcium levels, the spinach farm's soil had adequate Magnesium while the lettuce and amaranthus farms' soils had moderate Magnesium contents and the control's, green onion and pumpkin leaf farms' soils had low Magnesium contents. The amaranthus farm's soil had adequate Potassium contents while the soils of the lettuce, green onion, spinach and pumpkin leaf farms and the control plot had low Potassium contents. Sodium content was low in the soil of the pumpkin leaf farm but moderate in the soil of the control plot, lettuce, green onion, spinach and amaranthus farms. The values ranged from 0.253 Cmol/kg to 1.945 Cmol/kg, 0.328 Cmol/kg to 3.324 Cmol/kg, 0.139 Cmol/kg to 1.231 Cmol/kg and 0.185 Cmol/kg to 0.410 Cmol/kg with means of 1.427 Cmol/kg, 2.141 Cmol/kg, 0.368 Cmol/kg and 0.357 Cmol/kg respectively for the vegetable farms. The values of the control are 0.558 Cmol/kg, 0.304 Cmol/kg, 0.144 Cmol/kg and 0.341 Cmol/kg respectively. The micronutrients; Manganese, Iron, Copper and Zinc for the vegetable farms ranged from 4.55 mg/kg to 137.5 mg/kg, 57.2 mg/kg to 226.1 mg/kg, 2.57 mg/kg to 4.45 mg/kg and 0.13 mg/kg to 0.65 mg/kg respectively with means of 80.49 mg/kg, 127.24 mg/kg, 3.72 mg/kg and 0.393 mg/kg respectively. While the Mn, Fe, Cu and Zn of the control are 3 mg/kg, 208 mg/kg, 2.37 mg/kg and 1.25 mg/kg respectively with. Therefore, there were adequate Iron and Copper contents in the soils of all the vegetable farms and the control plot. The Manganese contents were high in the soils of the lettuce, green onion, spinach and amaranthus farms and moderate in the soils of the control plot and the pumpkin leaf farm.

All the physical soil properties of the lettuce, green leaf, amaranthus and pumpkin leaf farms had strong positive correlation ($P < 0.01$) with each other, however the sand of the spinach farm had negative correlation ($P < 0.05$) with silt, clay, saturated hydraulic conductivity, bulk density and porosity. In the control plot's soil, silt had no correlation with sand, clay, saturated hydraulic conductivity, bulk density and porosity.

Significant positive correlation ($P < 0.01$) existed between all the chemical properties of the lettuce, amaranthus and pumpkin leaf farms. However, the chemical soil properties of the green onion and spinach farms and the control had significant correlation but the Magnesium and Phosphorous of the Green onion farm were correlated at $P < 0.05$ and there was no significant correlation between total Nitrogen and pH, organic Carbon, Phosphorous, Calcium, Magnesium, Potassium, Sodium and Acidity of the soil of the green onion farm. The soil Phosphorous of the spinach farm had significant positive correlation with pH, total Nitrogen, Organic Carbon, Potassium, Sodium, Calcium, Magnesium and Acidity. There was significant positive correlation between the micronutrients (Manganese, Zinc, Iron and Copper) of all the vegetable farms and the control plot.

7. Recommendations

For sustainable crop production, it is recommended that the pH of the soils be improved to near neutral and liming is not required until the pH level subsides. To minimize Nitrogen loss, crop rotation and the use of cover crops preferably non leguminous crops such as phacelia (*Phacelia tanacetifolia*) and annual rye (*Secale cereal*) during fallow periods is advised [8] because cover crops could reduce field runoff and associated sediment loss and help control erosion.

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