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Effect of Organic Farming Practices on Soil Chemical Properties

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A survey was conducted in the Bellary district Northern Dry Zone of Karnataka (zone-3). Only those farmers who had been practicing it for more than five years were selected and information on the type and quantity of organics used by them in different cropping systems viz., Groundnut, Ragi, Onion, Drumstick and Maize was collected, Soil samples from the selected 30 organic farms and the neighboring conventional farms under the same cropping system were also collected. The results revealed that organic farming approaches enhance the chemical composition of soil, augment the availability of macro and micronutrients, and elevate the soil's organic carbon status—

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all of which are critical for sustainable crop yields. It is possible to draw the conclusion that organic agricultural practices positively impact soil characteristics and sustainable yield, hence improving soil health.

Keywords: Organic farming; conventional farming; cropping system; nutrient status.

1.INTRODUCTION

Prior to the 1960s, when inorganic chemical fertilizers started to gain traction, developing countries customarily and preferentially used organic manures, such as composts, crop residues, animal manures, and green manures. In contrast to organic manures, chemical fertilizers were more readily available and less bulky, making them easier to handle, store, and transport. They outperformed several organic manures in crop response. This was especially true during the so-called "Green Revolution," when high-yielding crop varieties were brought in that responded well to high fertilizer dosages. The use of chemical fertilizers replaced organic based nutrient application in a significant way due to the introduction of high yielding varieties and an expansion in the area under guaranteed irrigation.

In several developing nations throughout the early 1970s, sources of crop nutrients were essentially supplanted by chemical fertilizers. As a result, there was a decrease in the intake of organic manures as well as an excessive and unbalanced use of high analysis fertilizers, which led to further issues with soil fertility like acidity and alkalinity as well as multiple nutrient deficiencies, particularly in secondary and micronutrients, and a complete loss of soil health.

These days, organic farming is gradually becoming more and more popular. Farmers have seen a decline in soil health as a result of careless agronomic techniques. While it is commonly known that adding organic residues and manures can improve soil health, nothing is known about how switching from traditional chemical farming to fully organic farming affects the qualities of the soil. Given that a number of farmers in Karnataka have begun to practice organic farming in recent years, a study was carried out in the farmer's field to determine how the use of organic farming practices has affected the physical, chemical, and biological properties of the soil in various cropping systems. Keeping these facts in mind, the present investigation was taken up with the following objective. To know the effect of organic farming practices on soil chemical properties.

2. MATERIALS AND METHODS

In order to identify the farmers who practice organic farming in the Bellary district of Karnataka's Northern Dry Zone (Zone-3), a survey was carried out with assistance from the Department of Agriculture, NGOs, KVKs, and Extension Workers. Only farmers who had been engaged in this practice for more than five years were chosen, and data regarding the kind and quantity of organic materials they employed in their main agricultural systems was gathered.

2.1 Location of Study Area

The largest of all the agroclimatic zones in the state, zone 3 is primarily found on the black soils of North Karnataka. Its overall area is 48.74 lakh hectares geographically. Its predominant agricultural nature is reflected in the 76.60% of its land area that is under cultivation. The Northern Dry Zone is situated between 300 and 460 meters above mean sea level at latitude 170 25' N and longitude 760 65' E. With an average annual rainfall of 613 mm, it is distinguished by the lowest rainfall in the state of Karnataka. Its soils are the most fertile; medium black soils predominate, followed by deep and shallow black soils.

2.2 Soil Sampling

In the winter of 2020 and 2021, soil samples were taken from 30 organic farms that were chosen and had varying cropping strategies. These farms were located in various taluks of Bellary district, which is in the Northern Dry Zone of Karnataka. To further understand how organic farming affects soil qualities, soil samples from nearby conventional farms that use the same crop/cropping strategy were also gathered and used as a control.

2.3 Preparation and Storing of The Soil Samples

The gathered soil samples were shade-air dried. To remove the larger pieces (>2 mm), the air-dried samples were crushed using a wooden pestle and mortar and then run through a 2 mm sieve. The soil samples that had been sieved were used for different chemical analyses and kept in separate, dry, and clean containers.

3. CHEMICAL PROPERTIES OF SOIL

Soil reaction: Soil pH was determined in 1:2.5 soil:water suspension as described by Jackson [1] using systronic digital 331 pH meter.

Electrical conductivity: Electrical conductivity of the soil was determined in the 1:2.5 soil to water extract ratio Jackson [1] by using systronic digital meter 304 and expressed as ds^{-1} m.

Soil Organic carbon: Organic carbon was estimated by Walkley and Black wet oxidation method [2].

Soil organic carbon (g kg^{-1}) =

$$\frac{(\text{Blank TV} - \text{Sample TV}) \times \text{N. of FAS} \times 0.003 \times 1000}{\text{Weight of soil (g)}}$$

Cation exchange capacity: Cation exchange capacity of soils was determined by Ammonium acetate method [3]. Five grams of soil was shaken for five minutes with 33 ml of 1N sodium acetate of pH 8.2 in a stoppered centrifuge tube. The supernatant solution was decanted and extraction was repeated for two more times. Then, the soil was washed with isopropyl alcohol in the same manner to remove excess of sodium adsorbed on the soil exchange complex. The adsorbed sodium was later replaced by ammonium (NH^+) by treating the soil with neutral normal ammonium acetate (pH 7.0). The displaced sodium was determined by flame photometer.

Available nitrogen (kg ha^{-1}): Available nitrogen was estimated by alkaline $KMnO_4$ method where the organic matter in soil was oxidized with hot alkaline $KMnO_4$ solution. The ammonia (NH_3) evolved during oxidation was distilled and trapped in boric acid mixed indicator solution. The amount of NH_3 trapped was estimated by titrating with standard acid [4].

Available N (kg ha^{-1}) =

$$\frac{\text{TV x N. of } H_2SO_4 \text{ x } 0.014 \text{ x } 100 \text{ x } 2.24 \text{ x } 10^6}{\text{Weight of soil sample (g)}}$$

Available phosphorus (kg ha^{-1}): Available phosphorus was extracted with sodium bicarbonate (0.5 *M*) at pH 8.5 (Olsen's reagent) and the amount of P in the extract was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wave length of 660 nm [1].

Available P_2O_5 (kg ha^{-1}) =

$$\frac{\text{Graph ppm x Volume of extract x Volume made x } 2.29 \text{ x } 2.24 \text{ x } 10^6}{10^6 \text{ x Aliquot taken x Weight of soil sample}}$$

Available potassium (kg ha^{-1}): Available potassium was extracted with neutral normal ammonium acetate and determined using flame photometer [1].

Available K_2O(kg ha^{-1})=

$$\frac{\text{Graph ppm x Volume of extract x Volume made x } 1.20 \text{ x } 2.24 \text{ x } 10^6}{10^6 \text{ x Aliquot taken x Weight of soil sample}}$$

Available Micronutrients (mg kg^{-1}): The available iron, zinc, copper and manganese were determined by atomic absorption flame photometer after extracting the soil with DTPA (Diethylene Triamine Penta Acetic acid and AAS method) as described by Jackson [1] and expressed in ppm.

Available micronutrients (mg kg^{-1}) =

$$\frac{\text{Graph ppm x Volume of extractant}}{\text{Weight of soil}}$$

4. RESULTS AND DISCUSSION

4.1 Soil Reaction (Ph) and Electrical Conductivity (Ec)

The data on soil pH and EC in different cropping systems is presented in Table 1. The results revealed that there was a slight decrease in both soil pH and EC due to organic farming practices. In a groundnut based cropping system the mean soil pH and EC values ranged from 7.91 to 7.50 and 0.34 to 0.31 dS m^{-1} respectively. The corresponding values for soils in the ragi based cropping system were 8.21 to 7.67 and 0.33 to 0.30 dS m^{-1} respectively, 8.30 to 8.21 and 0.33 to 0.30 in the onion based cropping system, 8.01 to 7.64 and 0.34 to 0.30 dS m^{-1} respectively, in the drumstick based cropping system; 7.85 to 7.32 and 0.33 to 0.30 dS m^{-1} respectively, in the maize based cropping system.

The soil pH decreased due to the continuous application of FYM due to the deactivation of Fe^{3+} and Al^{3+} by chelating effect and release of basic cations through the decomposition of organic manure [5].

4.2 Soil Organic Carbon and Cation Exchange Capacity

The organic carbon content and cation exchange capacity of soils under different cropping systems is presented in (Table 2).

on an average in a groundnut based cropping system, the organic carbon content and cation exchange capacity increased from 7.00 g kg^{-1} and 13.28 (cmol (p+)/kg) in conventional farm to 8.30 g kg^{-1} and 15.50 (cmol (p+)/kg) in organic farm in soil, accounting for an increase of 19.17 and 16.65 per cent in soil. In a ragi based cropping system on average, the organic carbon content and cation exchange capacity increased from 6.60 g kg^{-1} and 12.62 (cmol (p+)/kg) in conventional farm to 7.50 g kg^{-1} and 14.71 (cmol (p+)/kg) in organic farm in soil, accounting for an increase of 14.91 and 16.65 per cent in soil.

on average in a onion based cropping system, the organic carbon content and cation exchange capacity increased from 6.70 g kg^{-1} and 12.81 (cmol (p+)/kg) in conventional farm to 7.40 g kg^{-1} and 14.60 (cmol (p+)/kg) in organic farm in soil, accounting for an increase of 10.34 and 13.99 per cent in soil. In drum stick based cropping system, the organic carbon content and cation exchange capacity increased from 6.70 g kg^{-1} and 12.91 (cmol (p+)/kg) in conventional farm to 7.40 g kg^{-1} and 14.70 (cmol (p+)/kg) in organic farm in soil, accounting for an increase of 10.46 and 13.84 per cent in soil.

On average in a maize based cropping system, the organic carbon content and cation exchange capacity increased from 6.90 g kg^{-1} and 13.01 (cmol (p+)/kg) in conventional farm to 7.60 g kg^{-1} and 15.00 (cmol (p+)/kg) in organic farm in soil, accounting for an increase of 10.47 and 15.30 per cent in soil. Due to the build-up of organic carbon in soil due to continuous application of organic manure and crop residue, subsequent decomposition of these residues by higher microbial population which might have resulted in increased soil organic carbon, as reported by Krishnamurthy [6] where regular addition of organics such as FYM and compost increased the organic carbon status in soils.

4.3 Available Soil Nitrogen

The data on available nitrogen (N) content of soils presented in Table 3. All the soils were low in available N status irrespective of type of farming and cropping system.

In a groundnut based cropping system, the available nitrogen content increased on average from 160.09 to 180.90 kg ha^{-1} in these soils. Among the soils of six organic farms, the highest increase of 12.98 per cent. In a ragi based cropping system, the average of six soils indicated an increase in available nitrogen content from 155.99 kg ha^{-1} in conventional farms to 177.83 kg ha-1 in organic farms in these soils. The overall increase in nitrogen content due to organic farming was 14.00 per cent.

The soils from the onion based cropping system also showed an increase in nitrogen content from 156.38 kg ha^{-1} in conventional farm soil to 178.28 kg ha^{-1} in organic farm soil. In a drumstick based cropping system, the average was 16.92 per cent in these soils (152.81 to 178.82 kg ha^{-1}) respectively. In the maize cropping system, the average of six soils indicated that nitrogen content increased from 156.86 to 178.82 kg ha^{-1} in these soils.

The data on the available nitrogen (N) content of soil indicated that its values were higher in soils under organic farming than conventional farming, irrespective of cropping system followed. Organic matter application is also attributable to the greater multiplication of soil microbes caused by the addition of organic materials, which mineralize organically bound N into inorganic form [7].

4.4 Available Phosphorus in Soil

The data on available phosphorus content of soils are presented in Table 4. The soils under organic farming accounted for higher amounts than those under conventional farming.

In a groundnut based cropping system, the available phosphorus content increased from 19.23 kg ha^{-1} in conventional farms to 25.78 kg ha^{-1} in organic farms in these soils. The per cent increase over conventional farming was 34.21 per cent. In a ragi based cropping system, the average of six soils indicated an increase in available phosphorus content due to organic farming from 19.23 to 24.82 kg ha^{-1} in these soils, respectively. The average increase in these soils was 29.01 per cent.

Table 1. Soil pH and EC values in different cropping systems

Code	pH		Electrical conductivity (dS/m)	
	Organic farming	Conventional farming	Organic farming	Conventional farming
		Groundnut based cropping system		
G1	7.70	8.21	0.24	0.28
G2	7.20	7.06	0.27	0.3
G3	6.74	8.24	0.31	0.35
G4	7.48	7.69	0.29	0.31
G5	8.33	8.26	0.33	0.37
G6	7.55	8.01	0.41	0.43
Mean	**7.50**	**7.91**	**0.31**	**0.34**
		Ragi based cropping system		
R7	7.93	8.20	0.23	0.26
R8	6.53	8.28	0.31	0.33
R9	7.00	8.19	0.29	0.33
R10	8.10	8.12	0.27	0.29
R11	8.23	8.26	0.32	0.35
R12	8.24	8.22	0.37	0.4
Mean	**7.67**	**8.21**	**0.30**	**0.33**
		Onion based cropping system		
O13	8.41	8.52	0.23	0.26
O14	7.86	8.13	0.31	0.34
O15	8.36	8.38	0.28	0.32
O16	8.15	8.22	0.29	0.31
O17	8.23	8.28	0.32	0.35
O18	8.26	8.30	0.39	0.42
Mean	**8.21**	**8.30**	**0.30**	**0.33**
		Drumstick based cropping system		
D19	7.32	7.85	0.24	0.28
D20	7.45	7.79	0.28	0.33
D21	7.18	7.84	0.3	0.34
D22	7.56	7.95	0.27	0.3
D23	8.20	8.36	0.33	0.36
D24	8.18	8.27	0.38	0.41
Mean	**7.64**	**8.01**	**0.30**	**0.34**
		Maize based cropping system		
M25	7.11	7.84	0.26	0.28
M26	6.96	7.76	0.28	0.3
M27	7.12	7.58	0.31	0.36
M28	7.50	7.88	0.25	0.29
M29	7.42	7.78	0.33	0.37
M30	7.86	8.28	0.37	0.4
Mean	**7.32**	**7.85**	**0.30**	**0.33**

Table 2. Organic carbon and cation exchange capacity of soils under different cropping system

Code	Organic carbon (g kg^{-1})				Cation exchange capacity (cmol (p+)/kg)			
	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic
				Groundnut based cropping system				
G1	7.00	5.80	20.00	16.02	15.54	12.95	20.00	9.05
G2	9.60	8.30	20.09		14.24	12.39	14.93	
G3	9.00	7.50	19.98		15.28	13.29	14.97	
G4	7.00	5.80	19.87		14.67	13.34	9.97	
G5	7.40	6.20	20.11		15.528	12.94	20.00	
G6	9.80	8.50	14.94		17.72	14.76	20.05	
Mean	**8.30**	**7.00**	**19.17**		**15.50**	**13.28**	**16.65**	
			Ragi based cropping system					
R7	9.40	7.80	20.05	7.10	14.32	11.94	19.93	18.63
R8	8.10	7.00	14.96		15.44	13.43	14.97	
R9	6.20	5.40	14.85		14.88	12.4	20.00	
R10	6.50	5.40	19.69		14.31	12.45	14.94	
R11	8.80	8.00	9.99		13.88	12.07	15.00	
R12	6.40	5.80	9.89		15.42	13.4	15.07	
Mean	**7.50**	**6.60**	**14.91**		**14.71**	**12.62**	**16.65**	
			Onion based cropping system					
O13	8.10	7.40	10.02	17.22	13.53	12.19	10.99	8.71
O14	8.00	7.30	10.03		15.33	13.69	11.98	
O15	6.10	5.50	10.01		13.69	11.89	15.14	
O16	6.40	5.80	10.11		14.52	13.09	10.92	
O17	8.70	7.90	9.89		14.01	12.19	14.93	
O18	6.80	6.10	11.97		16.53	13.78	19.96	
Mean	**7.40**	**6.70**	**10.34**		**14.60**	**12.81**	**13.99**	
			Drumstick based cropping system					
D19	8.70	7.90	9.95	10.82	14.1	12.82	9.98	7.71
D20	7.80	7.10	9.89		14.76	13.3	10.98	
D21	6.10	5.50	10.02		14.16	12.65	11.94	
D22	6.20	5.60	10.09		15.52	12.7	22.20	
D23	9.10	8.10	11.98		13.92	12.32	12.99	
D24	6.50	5.90	10.85		15.74	13.69	14.97	
Mean	**7.40**	**6.70**	**10.46**		**14.70**	**12.91**	**13.84**	
			Maize based cropping system					
M25	9.50	8.60	10.93	11.86	14.37	12.95	10.97	8.97
M26	7.80	7.10	9.89		14.86	12.39	19.94	
M27	6.30	5.70	10.02		16.4	13.67	19.97	
M28	6.00	5.40	12.00		14.45	12.57	14.96	
M29	9.40	8.50	10.00		14.08	12.69	10.95	
M30	6.50	5.90	9.96		15.83	13.76	15.04	
Mean	**7.60**	**6.90**	**10.47**		**15.00**	**13.01**	**15.30**	

In an onion based cropping system, the average of six soils showed an increase in available phosphorus content from 20.19 kg ha^{-1} in conventional farms to 27.06 kg ha^{-1} in organic farms in these soils. The average increase in these soils was 34.08 per cent. In drumstick based cropping system the average of six farms showed an increase of soil phosphorus content due to organic farming from 20.59 to 28.22 kg ha^{-1} in soils, respectively. The overall increase in phosphorus content due to organic farming was 36.98 per cent.

In the maize cropping system, the average of six farms indicated an average increase in available phosphorus content due to organic farming from 19.75 to 27.26 kg ha^{-1} in these soils, respectively. The average increase in these soils was 38.03 per cent. The results of available phosphorus were increased under organic farming in all the cropping systems compared to conventional farming. Due to FYM application with the contribution of P by the organics to the soil available pool and coating of organic material on sesquioxides, which reduces the phosphate fixing capacity of soil. Similar observations were also reported by Bharadwaj and Omanwar [8].

Table 3. Available nitrogen (kg/ha) in soils under different cropping systems

Code	Organic farming	Conventional farming	% Increase over conventional farming	T-test statistic
		Groundnut based cropping system		
G1	171.64	151.89	12.91	
G2	168.32	148.96	12.99	
G3	180.98	160.16	12.86	
G4	177.69	157.25	12.96	41.42
G5	191.51	169.48	13.11	
G6	195.24	172.78	13.06	
Mean	**180.90**	**160.09**	**12.98**	
		Ragi based cropping system		
R7	163.07	143.05	14.06	33.48
R8	187.69	164.64	14.10	
R9	163.27	143.22	14.07	
R10	175.82	154.22	13.91	
R11	182.06	159.70	13.89	
R12	195.07	171.11	13.99	
Mean	**177.83**	**155.99**	**14.00**	
		Onion based cropping system		
O13	171.48	150.42	14.08	6.83
O14	182.33	159.94	14.10	
O15	173.80	152.46	13.95	
O16	170.64	149.69	13.85	
O17	183.92	161.33	13.96	
O18	187.49	164.47	13.89	
Mean	**178.28**	**156.38**	**13.97**	
		Drumstick based cropping system		
D19	163.91	140.10	16.85	42.72
D20	188.96	161.50	16.95	
D21	174.77	149.38	16.89	
D22	171.60	146.66	16.96	
D23	184.94	158.07	16.89	
D24	188.54	161.15	16.98	
Mean	**178.79**	**152.81**	**16.92**	
		Maize based cropping system		
M25	173.16	151.89	13.96	47.21
M26	169.81	148.96	13.86	
M27	187.85	164.78	14.11	
M28	168.92	148.18	14.07	
M29	189.49	166.22	13.96	
M30	183.71	161.15	14.17	
Mean	**178.82**	**156.86**	**14.02**	

4.5 Available Potassium in Soil

The data on available potassium content of soils under different cropping systems is given in Table 5.

In a groundnut based cropping system on average, the available potassium content increased from 223.37 kg ha^{-1} in conventional farms to 250.18 kg ha^{-1} in organic farms in these soils. The per cent increase over conventional farming was 11.99 per cent. In the ragi based cropping system, the average of six soils indicated an increase in available potassium content due to organic farming from 213.04 to 246.01 kg ha^{-1} in these soils, respectively. The average increase in these soils was 15.45 per cent.

In an onion based cropping system, the average of six soils showed an increase in available potassium content from 217.99kg ha^{-1} in conventional farms to 246.33 kg ha^{-1} in organic farms in these soils. The average increase in these soils was 13.01 per cent. In drumstick based cropping system the average of six farms showed an increase in soil potassium content due to organic farming from 218.15 to 247.59 kg ha^{-1} in soils, respectively. The overall increase in potassium content due to organic farming was 13.64 per cent.

In the maize cropping system, the average of six farms indicated an average increase in available potassium content due to organic farming from 217.20 to 247.61 kg ha^{-1} in soils, respectively. The average increase in soil was 13.99 per cent.

The increase in available potassium in the soils of organic farms could be attributed to the direct addition of potassium to the available pool of soil from FYM and vermicomposts. The beneficial effect of FYM on the available potassium might also attributed to the reduction of potassium fixation [9].

4.6 DTPA Extractable Micronutrients in Soil

The data on DTPA extractable micronutrient**s** content of soils under different cropping systems is given in (Tables 6 and 7).

In a groundnut based cropping system on average the zinc, copper, iron and manganese content increased from 0.75, 4.71, 22.15 and 24.65 ppm in conventional farms to 0.98, 6.32, 29.72 and 29.62 ppm in organic farms in these soils, accounting for an increase of 32.29, 34.03, 34.15 and 21.24 per cent respectively. In a ragi based cropping system on average the zinc, copper, iron and manganese content increased from 0.92, 5.24, 17.77 and 26.94, ppm in conventional farms to 1.18, 7.02, 23.81 and 30.98 ppm in organic farms in these soils, accounting for an increase of 28.96, 33.91, 34.15 and 21.24 per cent respectively.

Table 4. Available phosphorus (kg/ha) in soils under different cropping systems

Code	Organic farming	Conventional farming	% Increase over conventional farming	T-test statistic
		Groundnut based cropping system		
G1	23.74	17.72	33.95	36.94
G2	23.50	17.54	33.89	
G3	26.85	20.04	33.96	
G4	26.41	19.71	34.11	
G5	27.51	20.53	34.12	
G6	26.64	19.88	34.21	
Mean	**25.78**	**19.23**	**34.04**	
		Ragi based cropping system		
R7	23.34	18.09	28.91	69.21
R8	24.50	18.99	28.95	
R9	25.32	19.63	28.96	
R10	24.91	19.31	29.11	
R11	25.95	20.12	29.12	
R12	24.87	19.28	28.96	
Mean	**24.82**	**19.23**	**29.01**	
		Onion based cropping system		
O13	25.46	19	34.11	54.53
O14	25.71	19.19	34.02	
O15	28.48	21.25	34.06	
O16	27.75	20.71	34.08	
O17	27.24	20.33	34.11	
O18	27.71	20.68	34.12	
Mean	**27.06**	**20.19**	**34.08**	
		Drumstick based cropping system		
D19	26.03	19	37.01	57.48
D20	27.89	20.36	37.02	
D21	28.84	21.05	37.08	
D22	28.37	20.71	36.99	
D23	29.55	21.57	36.89	
D24	28.61	20.88	36.96	
Mean	**28.22**	**20.59**	**36.98**	
		Maize based cropping system		
M25	27.56	19.97	38.00	64.31
M26	26.54	19.23	38.05	
M27	26.37	19.11	38.06	
M28	29.19	21.15	38.11	
M29	27.16	19.68	37.99	
M30	26.74	19.38	37.96	
Mean	**27.26**	**19.75**	**38.03**	

Table 5. Available potassium (kg/ha) in soils under different cropping systems

Code	Organic farming	Conventional farming	% Increase over conventional farming	T-test statistic
		Groundnut based cropping system		
G1	246.53	220.12	11.95	56.81
G2	230.96	206.21	11.96	
G3	255.63	228.24	11.89	
G4	256.84	229.32	11.96	
G5	261.20	233.21	12.10	
G6	249.92	223.14	12.06	
Mean	**250.18**	**223.37**	**11.99**	
		Ragi based cropping system		
R7	235.61	203.11	15.99	38.70
R8	252.23	223.21	12.89	
R9	246.21	212.25	15.96	
R10	248.39	214.13	15.97	
R11	251.88	217.14	15.86	
R12	241.76	208.41	16.05	
Mean	**246.01**	**213.04**	**15.45**	
		Onion based cropping system		
O13	245.38	217.15	13.06	152.03
O14	249.87	221.12	13.08	
O15	245.45	217.21	13.09	
O16	246.50	218.14	12.98	
O17	251.01	222.13	12.89	
O18	239.80	212.21	12.93	
Mean	**246.33**	**217.99**	**13.01**	
		Drumstick based cropping system		
D19	249.86	220.14	13.56	58.40
D20	233.96	206.13	13.48	
D21	265.83	234.21	13.68	
D22	245.32	216.14	13.78	
D23	245.30	216.12	13.86	
D24	245.31	216.13	13.45	
Mean	**247.59**	**218.15**	**13.64**	
		Maize based cropping system		
M25	236.14	207.14	13.89	54.54
M26	258.97	227.17	13.99	
M27	231.76	203.30	14.06	
M28	256.74	225.21	14.09	
M29	251.06	220.23	14.12	
M30	250.97	220.15	13.78	
Mean	**247.61**	**217.20**	**13.99**	

In an onion based cropping system on average the zinc, copper, iron and manganese content increased from 0.73, 4.68, 17.01 and 19.74 ppm in conventional farms to 0.94, 6.26, 21.69 and 22.70 ppm in organic farms in these soils, accounting for an increase of 29.03, 33.65, 30.29 and 14.98 per cent respectively. In a drumstick based cropping system on average the zinc, copper, iron and manganese content increased from 0.63, 4.80, 16.20 and 22.17 ppm in conventional farms to 0.81, 6.44, 18.15 and 25.13 ppm in organic farms in these soils, accounting for an increase of 29.02, 33.99, 12.01 and 13.99 per cent respectively.

In a maize based cropping system on average the zinc, copper, iron and manganese content increased from 0.64, 5.29, 15.41 and 25.83 ppm in conventional farms to 0.83, 7.08, 17.25 and 29.22 ppm in organic farms in these soils, accounting for an increase of 29.94, 33.91, 12.04 and 13.50 per cent respectively. The result revealed that the concentration of available Zn, Cu, Fe and Mn in all the soils, irrespective of the type of farming or cropping system was above critical limits. But, however, the soils under organic farming recorded a much higher concentration of micronutrients than soils under conventional farming in all the cropping systems. The addition of large quantities of organic manures every year under organic farming practice was the cause of such a marked increase in DTPA- extractable micronutrients [10].

Table 6. DTPA extractable zinc and copper (ppm) in soils under different cropping system

Code	Zn				Cu			
	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic
			Groundnut based cropping system					
G1	0.18	0.13	38.98	5.34	3.54	2.64	33.84	5.84
G2	1.20	0.93	28.99		9.27	6.92	33.87	
G3	0.54	0.39	38.96		4.30	3.21	34.13	
G4	1.29	1.00	28.95		4.03	3.01	34.22	
G5	1.28	1.00	28.89		7.64	5.70	34.10	
G6	1.40	1.08	28.96		9.11	6.80	34.03	
Mean	**0.98**	**0.75**	**32.29**		**6.32**	**4.71**	**34.03**	
			Ragi based cropping system					
R7	0.23	0.18	28.78	4.66	7.46	5.57	33.96	7.89
R8	1.83	1.42	28.96		5.25	3.92	33.94	
R9	1.56	1.21	28.90		8.16	6.09	33.97	
R10	1.71	1.33	28.96		9.07	6.77	33.95	
R11	0.81	0.63	29.1		3.54	2.64	33.75	
R12	0.96	0.74	29.05		8.66	6.47	33.86	
Mean	**1.18**	**0.92**	**28.96**		**7.02**	**5.24**	**33.91**	
			Onion based cropping system					
O13	0.39	0.31	29.08	4.94	4.02	3.00	34.14	6.19
O14	1.40	1.09	29.05		4.46	3.33	33.86	
O15	1.04	0.81	28.95		9.25	6.90	33.92	
O16	1.54	1.20	28.93		8.80	6.57	34.02	
O17	0.66	0.51	29.11		3.95	2.99	32.01	
O18	0.59	0.46	29.06		7.05	5.26	33.93	
Mean	**0.94**	**0.73**	**29.03**		**6.26**	**4.68**	**33.65**	
			Drumstick based cropping system					
D19	0.51	0.40	29.03	3.57	7.12	5.31	34.10	9.73
D20	0.69	0.53	28.89		7.62	5.69	33.91	
D21	0.64	0.49	28.93		8.74	6.52	33.97	
D22	1.02	0.79	29.06		4.81	3.59	33.98	
D23	1.80	1.40	29.12		5.44	4.06	34.11	
D24	0.19	0.15	29.07		4.90	3.66	33.88	
Mean	**0.81**	**0.63**	**29.02**		**6.44**	**4.80**	**33.99**	
			Maize based cropping system					
M25	0.91	0.71	28.88	4.44	9.45	7.05	34.05	10.49
M26	0.68	0.52	28.79		6.07	4.53	34.05	
M27	0.60	0.46	29.06		5.27	3.94	33.60	
M28	0.98	0.76	29.02		8.76	6.54	33.94	
M29	0.21	0.16	34.95		6.50	4.85	33.92	
M30	1.62	1.25	28.96		6.46	4.82	33.93	
Mean	**0.83**	**0.64**	**29.94**		**7.08**	**5.29**	**33.91**	

Table 7. DTPA extractable Iron and Manganese (ppm) in soils under different cropping system

Code	Fe				Mn			
	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic	Organic farming	Conventional farming	%Increase over conventional farming	T-test statistic
			Groundnut based cropping system					
G1	32.79	24.29	35.01	8.05	23.34	17.42	33.95	
G2	36.98	27.60	33.98		31.46	23.48	33.97	
G3	14.28	10.66	33.95		39.19	34.08	15.00	6.22
G4	24.69	18.43	33.99		39.81	34.62	15.00	
G5	38.64	28.84	33.98		22.31	19.40	15.02	
G6	30.92	23.08	33.98		21.62	18.88	14.51	
Mean	**29.72**	**22.15**	**34.15**		**29.62**	**24.65**	**21.24**	
			Ragi based cropping system					
R7	27.91	20.83	34.02	7.40	35.48	30.86	14.96	8.41
R8	15.19	11.34	33.94		39.31	34.19	14.99	
R9	34.21	25.53	34.00		38.53	33.51	14.97	
R10	16.60	12.39	33.95		17.69	15.39	14.95	
R11	19.11	14.26	33.97		22.01	19.14	15.02	
R12	29.86	22.29	33.97		32.84	28.56	15.00	
Mean	**23.81**	**17.77**	**33.98**		**30.98**	**26.94**	**14.98**	
			Onion based cropping system					
O13	12.45	9.29	33.95	8.69	20.88	18.16	14.98	24.44
O14	25.20	18.81	33.95		22.71	19.75	14.97	
O15	18.85	14.07	33.95		22.05	19.17	14.97	
O16	16.22	12.11	33.92		27.17	23.63	14.99	
O17	23.93	17.86	33.99		21.85	19.00	14.97	
O18	33.51	29.92	11.98		21.52	18.71	15.00	
Mean	**21.69**	**17.01**	**30.29**		**22.70**	**19.74**	**14.98**	
			Drumstick based cropping system					
D19	24.02	21.45	12.02	9.81	15.42	13.41	14.99	5.62
D20	12.16	10.86	12.01		35.41	30.79	15.00	
D21	22.37	19.97	12.00		14.81	12.87	15.01	
D22	18.05	16.12	11.97		12.78	11.11	14.99	
D23	18.00	16.07	11.97		33.26	28.93	14.97	
D24	14.28	12.74	12.10		39.13	35.90	8.99	
Mean	**18.15**	**16.20**	**12.01**		**25.13**	**22.17**	**13.99**	
			Maize based cropping system					
M25	10.67	9.48	12.57	8.90	32.54	29.05	12.02	7.96
M26	14.64	13.08	11.94		13.06	11.26	16.01	
M27	22.72	20.31	11.86		33.82	30.20	11.99	
M28	23.06	20.59	12.00		39.89	35.62	11.99	
M29	14.71	13.14	11.94		20.93	18.36	14.02	
M30	17.72	15.83	11.92		35.10	30.52	15.01	
Mean	**17.25**	**15.41**	**12.04**		**29.22**	**25.83**	**13.50**	

5. CONCLUSION

From the study, the results indicated that organic farming practices improve the chemical properties of soil, increase the available macro and micronutrients status and also increase the organic carbon status of soils, which is essential for sustainable production. It could be concluded that soil properties and sustainable yield get favorably influenced by organic farming practices which in turn would enhance soil health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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