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Comparative Study of Soil Properties and Organic Matter Fractions in Organic and Conventional Farms of Kerala, India

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Authors' contributions

This work was carried out in collaboration among all authors Authors NMV, GR and BJ designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ONMS managed the analyses of the study, literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Assessing various soil properties as influenced by organic farming in the selected certified organic and conventional farms of Kerala.
Study Design: Ten pairs of certified organic farms and nearby conventional farms were identified from different agroecological zones of Kerala and were analysed for physical, chemical and biological properties.
Place and Duration of Study: The research was conducted at College of Agriculture Vellayani, between December 2020 – June 2021.

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Methodology: Soil samples were collected from these farms and analyzed for soil physical, chemical and biological properties, organic carbon, total nitrogen, C: N ratio and organic matter fractions.
Results: Organic farms exhibited lower bulk density (1.15 Mg m^{-3}) and higher values in porosity (41.32%), water holding capacity (52.68%), mean weight diameter (1.87%), and water stable aggregates (73.59%) compared to conventional farms. Additionally, organic farms were found to be higher in electrical conductivity (0.09 dS m^{-1}), cation exchange capacity (5.98 C mol(p^+) kg^{-1}), total organic carbon (7.59%), total nitrogen (0.46%), and C:N ratio (16.14) in comparison to conventional farms. The concentrations of fulvic acid, humic acid, and humin are also greater in organic farms, with mean values of 5.45%, 3.56%, and 0.47%, respectively.
Conclusion: Organic farming has a significant role in improving the physical, chemical and biological properties of the soil and also total carbon, total nitrogen and the organic matter fractions.

Keywords: Agroecological zones; organic farms; conventional farms; total carbon; total nitrogen; humic acid; fulvic acid; humin.

1. INTRODUCTION

Indian agriculture has gained impressive development over the last few decades with an increase in food grain production from 51 million tonnes (MT) in 1950-51 to 250 MT during 2011-12 [1]. The green revolution changed India from a grain-deficit country to a grain surplus country by the use of hybrid varieties, synthetic varieties and plant protection chemicals. The excessive use of chemicals increased yield and productivity, but adversely affected soil health and the environment. The introduction of organic farming is a solution to mitigate these problems which are aimed at long-term sustainability, increased biodiversity, soil and environmental health, reduced pollution etc. The total area under organic certification process (registered under National Program for Organic Production) is 4339184.93 ha and India produced around 3496800.34 MT of certified organic products and the total volume of export during 2020-21 was 888179.68 MT [2].

Organic farming is gaining gradual impetus in Kerala and certified organic farms are increasing to supply safe food and reduce environmental pollution. Kerala's rich endowments of wide variety of crops especially spices, plantation crops, medicinal plants etc. is an ideal destination for promotion of organic farming due to the changing preferences worldwide towards organic and eco-friendly products.

Organic soil management practices modify many aspects of the soil environment including the soil physical, chemical and biological properties. The present study aimed at assessing various soil properties as influenced by organic farming in the selected certified organic and conventional farms of Kerala.

2. MATERIALS AND METHODS

A field survey was conducted and ten pairs of certified organic farms and nearby conventional farms were identified from different agroecological zones namely Northern zone (Kannur), High altitude/Hill zone (Wayanad), Central zone (Palakkad) and Southern zone (Thiruvananthapuram). All the organic farms selected were under organic certification for more than ten years. Soil samples were collected in December 2020. The study was conducted during 2020-2021. Two composite samples were taken from each farm, shade dried and processed and were analyzed for physical, chemical and biological properties and other parameters like total organic carbon, total nitrogen and organic matter fractions and the C:N ratio was also worked out based on the standard analytical procedures.

Soil textural fractions (sand, silt and clay percentage) were determined using the Bouyoucos hydrometer method [3] and the textural class was found from the textural triangle of USDA. The bulk density and the water-holding capacity of the soil were determined by the core method given by [4]. Porosity was calculated from bulk density and particle density as outlined by [5]. Aggregate stability, water stable aggregate percentage and the mean weight diameter were found by wet sieving method described by [6].

The chemical properties included the soil pH, electrical conductivity and cation exchange capacity. Soil pH and electrical conductivity was determined in the 1:2.5 soil water suspension using pH meter and electrical conductivity meter respectively [7]. The cation exchange capacity of the soil was measured by extracting the soil using neutral normal ammonium acetate solution followed by steam distillation with boric acid mixed indicator solution and titration against 0.1 N sulphuric acid [7].

The biological properties studied included the soil enzyme (dehydrogenase) and soil protein (glomalin). Dehydrogenase activity of soil was estimated by the method outlined by [8]. Absorbance was read at 485 nm with Triphenyl formazan (TPF) as standard. The extraction method for glomalin was described by [9]. One gram of air-dried sample was taken and 8 ml of citrate (pH 7) was added and autoclaved and centrifuged a number of times to extract glomalin. The extract was then estimated for protein using Bradford dye-binding protein assay.

Total organic carbon content of the soil was estimated using the loss on ignition method [10] and the total nitrogen of the soil was determined by micro-Kjeldahl method outlined by [11]. It involved 3 steps: digestion using H_2SO_4 and digestion mixture, distillation with 40% NaOH and 4% boric acid mixed- indicator solution and titration against 0.02 N H_2SO_4. The C:N ratio of the soil was calculated using the total carbon and the total nitrogen [12]. The organic matter fractions *viz.*, fulvic acid, humic acid and humin were determined using the method outlined by [13].

3. RESULTS AND DISCUSSION

3.1 Soil Physical Properties

The results of soil textural analysis are given in Table 1. The results indicated that most of the soils belong to the textural class sandy loam. The content of sand in different organic farms ranged between 37.4% and 79.2% and in conventional farms it ranged between 54.2% and 84.2%. The silt content varied between 7.5% and 50% in organic and 5% to 35% whereas the clay content varied between 10.8% and 35.8% in both organic and conventional. Soils varied in textural class and mostly belonged to sandy loam, sandy clay, loam and loamy sand. Particle size distribution greatly influenced the physical, chemical properties and also organic matter accumulation and mineralization [14]. The presence of fine particle size fraction of silt and clay have a greater ability to sequester carbon (the texture of most of the selected farms was sandy loam). Fine particles have a greater ability to sequester carbon [15].

The results presented in Table 2 revealed a significant difference in soil bulk density of organic and conventional farming. A lower bulk density was noticed in organic farming system with a mean value of 1.15 Mg m^{-3} and for the conventional farming system the mean value was 1.27 Mg m^{-3}. This difference in bulk density between organic and conventional systems was mainly because of difference in the organic matter content of soil [16] and for improved physical properties in organic soil, organic matter addition is considered as the major driving force [17]. Bhogal et al. [18] reported that an addition of around 65 t ha^{-1} of organic carbon is needed to create a measurable change in the soil physical properties.

From Table 2 it is observed that organic and conventional management system has significant effect on soil porosity and higher porosity was found in organic soil than in conventional farming. The porosity was 24.40 – 49.58% in organic with an average of 41.32%. Organic matter inputs have a significant influence in increase in earth worm activity in soil which increased the burrowing effect [19]. Various organic inputs improved the activity of soil fauna which in turn make the soil more porous and granular [20]. Large number of bacteria and fungi present in organic matter releases various gum-like substances that make the soil bind together resulting in granular and porous in nature [21]. The porosity and aeration were found to be higher with an increased addition of organic matter [22]. A combined application of FYM, green manure, *Azotobacter* etc. had a positive effect on soil aggregation and porosity [23].

The data presented in Table 2 revealed that there is a significant difference in water holding capacity between organic and conventional farms. The water holding capacity ranged between 35.84% and 85.71% (mean 52.68%) in the organic farms and between 18.34% and 45.12% (mean 34.04%) in conventional farms. The presence of higher percentage of organic matter content resulted in higher percentage of water stable aggregates which in turn increased the porosity and aeration of soil and thus increased the water holding capacity [24]. The improvement in soil physical properties is due to the higher organic matter content which dilutes the denser fractions in the soil, improves the macro aggregate stability, porosity and there by water holding capacity [25, 22].

Table 1. Soil texture of organic and conventional farms

Sampling locations	Soil textural classes and fractions	Organic	Conventional
Knr* 1	Sand (%)	79.20	63.8
	Silt (%)	10.00	20.00
	Clay (%)	10.80	16.2
	Class	Loamy sand	Sandy loam
Knr 2	Sand (%)	54.20	54.20
	Silt (%)	10.00	10.00
	Clay (%)	35.80	35.80
	Class	Sandy clay	Sandy clay
Knr 3	Sand (%)	37.40	79.20
	Silt (%)	50.00	10.00
	Clay (%)	12.60	10.80
	Class	Loam	Loamy sand
Wynd* 1	Sand (%)	64.20	56.00
	Silt (%)	25.00	35.00
	Clay (%)	10.80	9.00
	Class	Sandy loam	Sandy loam
Wynd 2	Sand (%)	64.20	64.20
	Silt (%)	25.00	25.00
	Clay (%)	10.80	10.80
	Class	Sandy loam	Sandy loam
Wynd 3	Sand (%)	64.20	64.20
	Silt (%)	25.00	25.00
	Clay (%)	10.80	10.80
	Class	Sandy loam	Sandy loam
Pkd* 1	Sand (%)	67.20	79.20
	Silt (%)	17.00	10.0
	Clay (%)	15.8	10.80
	Class	Sandy loam	Loamy sand
Pkd 2	Sand (%)	79.20	84.20
	Silt (%)	10.00	5.00
	Clay (%)	10.80	10.80
	Class	Loamy sand	Loamy sand
Pkd 3	Sand (%)	73.8	64.20
	Silt (%)	7.5	25.00
	Clay (%)	18.7	10.80
	Class	Sandy loam	Sandy loam
TVM* 1	Sand (%)	64.20	63.8
	Silt (%)	25.00	20.00
	Clay (%)	10.80	16.2
	Class	Sandy loam	Sandy loam

** Knr- Kannur; Wynd- Wayanad; Pkd- Palakad; TVM- Thiruvananthapuram*

The mean weight diameter and percentage water stable aggregates were found to be more in organic farms than the conventional (Table 3). The water stable aggregates in organic farms ranged between 63.02-88.08 % and in conventional farms it ranged between 37.24-78.26% and there observed a significant difference between the two. The mean weight diameter was also found to be more in organic farm (1.87 mm) than the conventional (1.38 mm) farms but there was no significant difference. When comparing the different size fractions, the 1-2 mm size fraction was more in both the organic and conventional farms. The mass proportion of aggregates as affected by organic farming is presented in Fig. 1. The fraction of macro aggregates was found to be more than that of micro aggregates and the silt+ clay fraction both in organic and conventional farms. The percentage micro aggregates were found to be more in organic farms (62.83%) than the conventional (48.28%) whereas the percentage

Table 2. Effect of soil properties on soil physical properties

Sampling locations	Bulk density (Mg m^{-3})		Porosity (%)		Water holding capacity (%)	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Knr1- Kiliyanthara	1.03	1.10	43.82	40.00	57.77	37.50
Knr 2 - Kiliyanthara	1.27	1.27	36.50	23.80	44.31	32.32
Knr 3 – Kootupuzha	1.23	1.19	32.91	33.88	55.55	32.29
Wynd 1 – Kabanigiri	1.25	1.34	47.92	33.00	85.71	18.34
Wynd 2 – Pulpalli	1.21	1.26	49.58	24.40	35.84	27.88
Wynd 3 - Mullankolli	1.01	1.08	39.40	43.15	37.89	36.17
Pkd 1 - Kanjirappuzha	1.26	1.38	24.40	31.00	64.28	38.09
Pkd 2 - Kanjirappuzha	0.95	1.25	48.18	31.82	51.80	32.71
Pkd 3 - Kanjirappuzha	1.14	1.48	43.00	26.00	48.38	45.12
Tvm 1 - Vellayani	1.15	1.37	47.53	39.08	45.23	40.00
Range	0.95-1.27	1.08-1.48	24.40-49.58	23.80-43.15	35.84-85.71	18.34-45.12
Mean	1.15	1.27	41.32	32.61	52.68	34.04
t stat	2.254		2.620		3.62	
P value (P=.05)	.037		.017		.002	

Table 3. Effect of organic farming on mean weight diameter and water stable aggregates

Sampling locations	Mean weight diameter (mm)		Water stable aggregates (%)	
	Organic	Conventional	Organic	Conventional
Knr1- Kiliyanthara	1.97	1.48	82.6	71.62
Knr 2 - Kiliyanthara	2.8	2.08	88.08	78.26
Knr 3 – Kootupuzha	2.63	1.20	77.54	65.92
Wynd 1 – Kabanigiri	2.19	0.33	70.68	49.00
Wynd 2 – Pulpalli	1.46	1.50	63.02	39.30
Wynd 3 - Mullankolli	1.60	2.01	76.46	74.24
Pkd 1 - Kanjirappuzha	1.61	1.50	75.3	62.84
Pkd 2 - Kanjirappuzha	1.66	0.42	63.54	37.24
Pkd 3 - Kanjirappuzha	1.34	1.27	65.18	63.20
Tvm 1 - Vellayani	1.44	2.10	73.52	71.20
Range	1.34-2.80	0.33-2.10	63.02-88.08	37.24-78.26
Mean	1.87	1.38	73.59	61.28
t stat	1.881		2.331	
P value (P=.05)	.076		.032	

of micro aggregates and the silt+clay fraction was found to be more in conventional than the organic farms. In the organic farms the micro aggregates ranged from 4.74-31.44% (mean 19.98%) and the silt + clay fraction ranged from 10.38-26.06% (mean 17.19%) and in conventional it was 9.60-44.72% (mean 23.29%) and 15.68-54.5% (28.43%) respectively. As per the findings of [26] it is clear that the organic products increase the stability of the aggregates by strengthening and stabilizing the intra aggregate bonding. Conventional management systems are likely to have higher macro aggregate breakdown which results in less stable micro aggregates. In organic systems, the aggregate stability is improved if there is high organic carbon content in the soil [27]. The central factor responsible for the production and stabilization of soil aggregates is organic matter. Aggregate stability is greatly influenced by the binding action of humic substances. Microbial size and activity also have a role in stable aggregate formation [28].

3.2 Soil Chemical Properties

The soils from organic and conventional farms were in acidic range. The pH value ranged between 4.6 – 6.96 and 5.05 – 6.76 in organic and conventional farms respectively (Table 4). No significant difference was noticed with respect to soil pH in organic and conventional farm. The pH was found to be higher in conventional compared to organic farms. On decomposition of the organic residues, weak organic acids may be produced which result in the reduction of pH in organic soils [16]. Velmourougane et al. [29] also reported that the lower pH in the organic farm is due to the effect of organic manure on soil reaction.

The electrical conductivity of organic and conventional farms is given in Table 4 No significant difference was observed for electrical conductivity. The electrical conductivity value in organic farms ranged from 0.04 - 0.20 dS m^{-1} and for conventional farms 0.03 - 0.15 dS m^{-1}. The mean value for electrical conductivity was higher for organic farms (0.09 dS m^{-1}). A high EC value was reported by [30] in the organic soils (1.74 dS m^{-1}) than the conventional farms (1.18 dS m^{-1}) of Kerala. Eghball et al. [31] reported that the dissolved salts in the manures might be the reason for an increase in electrical conductivity of organic soils and [32] concluded that feed additives are the sources of these dissolved salts in the manures. Suja et al. [33] also reported that the addition of green manures may also contribute cations into the soil which reaches the subsurface mainly by leaching.

The CEC of surface soil (0-15 cm) varied between 4.2-8.7 C mol (p^+) kg^{-1} and 3.10-7.50 C mol (p^+) kg^{-1} in organic and conventional farms respectively (Table 4). A significant difference was observed and was found to be higher in organic farms compared to conventional. The higher CEC in organic soil is presumably because of the higher organic matter content [34] and due to increase in organic manure addition which might have increased total organic carbon content [35]. A continuous application of compost increased the nutrient content in the soil which also resulted in higher cation exchange capacity [36].

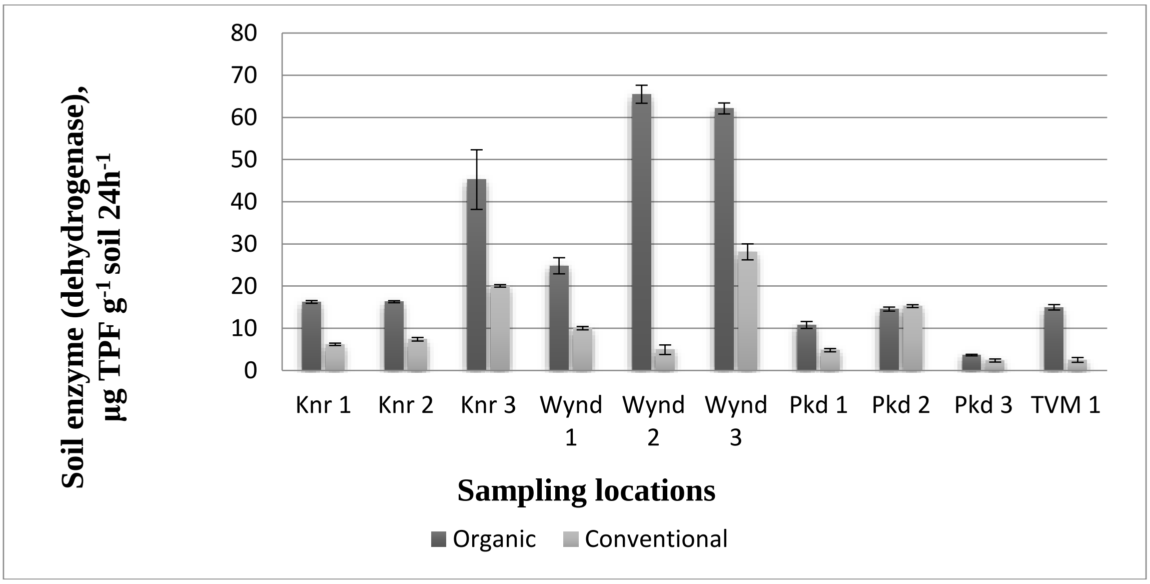

Fig. 1. Effect of organic farming on soil enzyme (dehydrogenase), µg TPF g^{-1} soil $24h^{-1}$

Table 4. Effect of organic farming on chemical properties

Sampling locations	Soil pH		Electrical conductivity (dSm^{-1})		Cation exchange capacity (C mol(p^+) kg^{-1})	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Knr1-Kiliyanthara	6.01	5.07	0.09	0.03	8.70	6.40
Knr 2 - Kiliyanthara	4.60	5.18	0.09	0.03	8.30	7.50
Knr 3 – Kootupuzha	5.30	6.06	0.04	0.03	4.20	3.90
Wynd 1 – Kabanigiri	6.96	6.54	0.06	0.06	5.20	4.00
Wynd 2 – Pulpalli	6.46	5.82	0.11	0.09	6.00	4.90
Wynd 3 - Mullankolli	5.87	6.76	0.05	0.10	5.20	4.00
Pkd 1 - Kanjirappuzha	5.54	5.82	0.10	0.03	5.00	3.20
Pkd 2 - Kanjirappuzha	5.78	5.65	0.08	0.15	5.70	4.50
Pkd 3 - Kanjirappuzha	5.45	5.05	0.07	0.04	4.70	3.10
Tvm 1 - Vellayani	5.16	5.54	0.20	0.10	6.80	4.50
Range	4.60-6.96	5.05-6.76	0.04-0.20	0.03-0.15	4.20-8.70	3.10-7.50
Mean	5.71	5.74	0.09	0.07	5.98	4.60
t stat	0.13		1.18		2.13	
P value (P=.05)	.89		.25		.04	

3.3 Soil Biological Properties

Dehydrogenase activity was found to be nonsignificant in organic and the conventional farm, however a higher value was noticed in organic farm than conventional farms (Fig. 1). In organic farms the dehydrogenase activity was 25.21 µg TPF g^{-1} soil 24 h^{-1} and in conventional farms, the values was 14.26 µg TPF g^{-1} soil 24 h^{-1}. Dehydrogenase is used as an indicator of overall soil microbial activity [37,38]. Soil microbial activity was constitutionally increased by organic farming which increased the enzyme activity in soil. The higher dehydrogenase activity in soils is a clear indication of increased microbial activity of soil which may be due to the presence of increased organic matter content which is essentially a good indication of soil health [30]. The higher decomposition or oxidation of organic matter in soil might be the reason for the increased dehydrogenase activity in the soil [33]. It also indicates that organic soils have higher rate of biological oxidation due to higher microbial activity [16]. The presence of larger quantities of organic substrates enhanced the microbial activity to produce enzymes [39] and also the increase in the release of root exudates by the crops stimulated the microbial growth [40].

The glomalin related soil protein was significantly influenced by organic farming. The glomalin was found to be higher in organic farms than conventional (Fig. 2). The glomalin in of organic farms ranged between 9.47-19.07 mg g^{-1} (mean 12.31 mg g^{-1}) and in conventional farms 3.50-9.58 mg g^{-1} (mean 6.18 mg g^{-1}). The high glomalin content in organic farm indicates the effect of organic manures in the arbuscular mycorrhizal spores, diversity and activity [41]. Glomalin content in soil is influenced by organic matter content in soil, so application of organic manure increases arbuscular mycorrhizal activity and thereby increases glomalin [42]. Application of manure and crop residues in soil improves the microhabitat for the growth of the microorganisms thus increasing their growth and also increasing the mycorrhizal hyphal density and effectiveness [43].

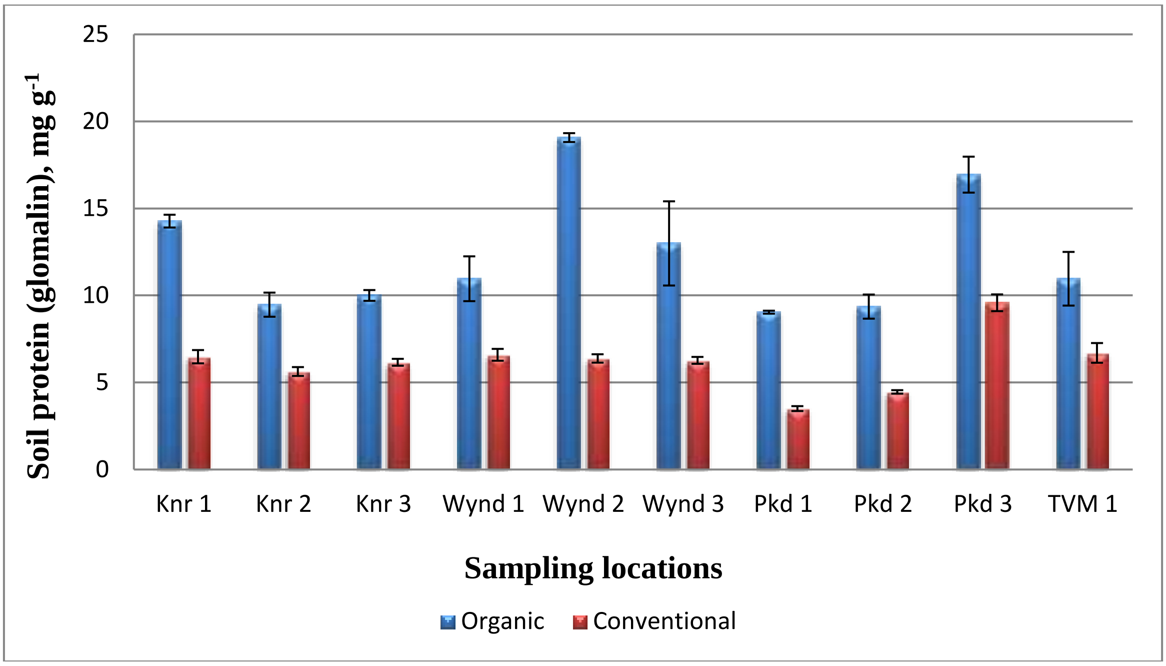

Fig. 2. Effect of organic farming on soil protein (glomalin), mg g^{-1}

3.4 Total Organic Carbon

The data on organic carbon status of soil are presented in Table 5 and observed a significant difference between organic and conventional farms. The total organic carbon content was found to be higher in organic farm compared to conventional. The organic carbon value ranged from 4.00-11.8% with a mean of 7.59% in organic farm and 1.80-9.30% with a mean of 4.71% in conventional farm. The addition of organic manures and the organic management systems maintained a high content of organic matter in soil [44]. Pulleman et al. [45] reported that the long-term application of animal manure significantly increased the soil organic matter in the organic soil than the conventional. Soil organic matter is also affected by soil type, topography, climate, long term cropping system etc. [46]. The soil carbon contents change occurs slowly in arable conditions and increases only a few tenth of a percent even after 10 to 15 years of organic management.

3.5 Total Nitrogen

The total nitrogen content was found to be significantly different in organic and conventional farming (Table 5). The total nitrogen content in organic farm was significantly higher than conventional farm which ranged from 0.32-0.62% (mean 0.46%) and 020-0.52% (mean 0.31%) respectively. There was higher rate of soil respiration [47,48] and enzymatic and dehydrogenase activity [16,30] indicates higher microbial activity in the organic soil which actively decompose and recycle nutrients in the organic residues. Nitrogen rich oil cakes and green manure and legume crops significantly add to the soil nitrogen pool [16].

3.6 C:N Ratio

There was no significant difference between the C: N ratio of organic and conventional farming (Table 5). The C:N ratio of soils of organic farms ranged between 10.00 - 20.00 with a mean of 16.14. The C:N ratio of soils of conventional farms ranged between 5.14 - 21.00 with a mean of 15.48.

3.7 Organic Matter Fractions

Organic and conventional farms showed a significant impact on the fulvic acid fraction of organic matter (Table 6). A higher value was observed in organic farms than conventional and with a range of 3.71-9.68% (mean 5.45%) and 1.18-3.57% (2.19%) for organic and conventional farms respectively. The humic acid fraction of organic matter showed a significance difference between organic and conventional farms and it ranged from 1.52-6.50% (mean 3.55%) and 0.54-4.6% (mean 2.24%) in organic and conventional farms respectively. The data presented in Table

26 revealed a significant impact of organic and conventional farming on humin content of soil. The highest mean value of 0.47% was recorded from organic farm and 0.25% from conventional farm. When a native soil was converted to conventional there was a decrease in organic matter fractions due to the reduction in amount of organic matter whereas the soils under organic management showed a higher content of these fractions [49]. The higher organic matter fractions in the organic farms might be due to the higher content of organic matter as a result of higher organic manure application. Humic acid was generally found to be less than the fulvic acid fraction. The ratio of humic acid to fulvic acid varied from 0.33 to 1.3% which indicates the presence of higher concentration of fulvic acid as compared to humic acid and it also indicates a lower decomposition rate of organic matter or frequent application of fresh manure to the soil [50].

The study contributes significantly to the understanding of the impact of organic farming on soil properties in the specific context of Kerala, India. The scientific relevance of this research lies in its comprehensive assessment of physical, chemical, and biological aspects of soil health, providing valuable insights into the efficacy of organic farming practices. By examining ten pairs of certified organic farms alongside nearby conventional farms across different agro-ecological zones, the study design ensures a robust representation of the diverse farming practices in Kerala.

The duration of the study, conducted between December 2020 and June 2021 at the College of agriculture Vellayani, adds temporal context to the findings, capturing potential seasonal variations in soil properties. the methodology employed, involving the collection and analysis of soil samples for various parameters such as bulk density, porosity, water holding capacity, total organic carbon, total nitrogen, c:n ratio, and organic matter fractions, demonstrates a systematic and thorough approach. The

Table 5. Effect of organic farming on total organic carbon, total nitrogen and C:N ratio

Sampling locations	Total organic carbon (%)		Total nitrogen (%)		C:N ratio	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Knr1- Kiliyanthara	10.00	9.30	0.62	0.52	16.13	17.95
Knr 2 - Kiliyanthara	11.80	7.40	0.59	0.37	20.00	20.00
Knr 3 – Kootupuzha	5.80	3.20	0.45	0.25	12.89	12.57
Wynd 1 – Kabanigiri	9.50	5.00	0.49	0.33	19.39	15.15
Wynd 2 – Pulpalli	7.40	3.20	0.42	0.29	17.65	11.03
Wynd 3 - Mullankolli	9.60	5.20	0.49	0.31	19.60	16.77
Pkd 1 - Kanjirappuzha	4.00	1.80	0.33	0.35	12.10	5.14
Pkd 2 - Kanjirappuzha	7.80	4.80	0.48	0.23	16.25	20.87
Pkd 3 - Kanjirappuzha	5.50	4.20	0.32	0.20	17.35	21.00
Tvm 1 - Vellayani	4.50	3.00	0.45	0.21	10.00	14.29
Range	4.00-11.80	1.80-9.30	0.32-0.62	0.20-0.52	10.00-20.00	5.14-21.00
Mean	7.59	4.71	0.46	0.31	16.14	15.48
t stat	2.652		3.691		0.344	
P value (P=.05)	.01		.00		.73	

Table 6. Effect of organic farming organic matter fractions

Sampling locations	Fulvic acid (%)		Humic acid (%)		Humin (%)	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Knr1- Kiliyanthara	9.68	1.50	5.32	2.52	0.95	0.72
Knr 2 - Kiliyanthara	5.63	2.43	3.15	1.05	0.35	0.14
Knr 3 – Kootupuzha	3.71	1.23	2.68	2.10	0.36	0.20
Wynd 1 – Kabanigiri	5.20	2.80	3.58	2.44	0.52	0.38
Wynd 2 – Pulpalli	3.91	1.95	2.70	1.72	0.65	0.14
Wynd 3 - Mullankolli	4.20	3.57	1.52	0.54	0.46	0.10
Pkd 1 - Kanjirappuzha	5.82	2.58	2.50	1.80	0.54	0.20
Pkd 2 - Kanjirappuzha	7.65	2.85	6.50	4.60	0.52	0.35
Pkd 3 - Kanjirappuzha	3.94	1.80	4.80	3.25	0.06	0.10
Tvm 1 - Vellayani	4.80	1.18	2.80	2.40	0.24	0.18
Range	3.71-9.68	1.18-3.57	1.52-6.50	0.54-4.60	0.06-0.95	0.10-0.72
Mean	5.45	2.19	3.56	2.24	0.47	0.25
t stat	5.013		2.19		2.206	
P value (P=.05)	0		.042		.041	

identification of significant differences between organic and conventional farms in terms of soil properties, including lower bulk density, higher water holding capacity, and increased concentrations of organic carbon and nitrogen, strengthens the scientific relevance of the study.

Furthermore, the comparison of organic and conventional farms in Kerala is contextualized within a broader scientific discourse by referencing the concentrations of fulvic acid, humic acid, and humin [51]. These organic matter fractions play a crucial role in soil fertility and structure [52,53]. The study concludes that organic farming significantly improves soil physical [54], chemical [55], and biological properties [56], as well as total carbon, total nitrogen, and organic matter fractions, adds depth to the understanding of sustainable agricultural practices in tropical regions [57,58]. Additionally, the reference to studies on soil quality and productivity of tropical crops in Latin America provides a comparative perspective [59-61], enriching the scientific relevance of the research by placing it in a global context and allowing for potential cross-regional insights and applications [62,63,64,65].

4. CONCLUSION

From the study it is concluded that organic farming has a significant role in improving the physical, chemical and biological properties of the soil and also total carbon, total nitrogen and the organic matter fractions. Long term organic farming was found to be helpful in increasing soil health, quality, fertility and also improved environmental quality and food quality. In this decade of increasing area towards organic farming, the present study helps in identifying the benefits of organic farming in soil health and quality when compared to conventional systems.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Arjun, K. M. Indian agriculture- Status, importance and role in Indian economy. Int. J. Agric. Food Sci. 2013;4(4): 343-346. DOI:10.13140/RG.2.2.24142.66885
2. APEDA [Agricultural and processed food products export development authority]. Statistical database. 2022. Accessed 02 September 2022. Available:http://apeda.gov.in/apedawebsite/organic/Organic_Products.htm
3. Bouyoucos, G. J. Directions for making mechanical analysis of soils by hydrometer method. Soil Science. 1936;4:225-228.
4. Gupta RP, Dakshinamoorthy C. Procedures for physical analysis of agrometeorological data. Indian Agricultural Research Institute, New Delhi; 1980.
5. Danielson RE, Sutherland PLM. Porosity, In: Klute, A. editor. Methods of Soil Analysis, Part I. Physical and Mineralogical Methods. Soil Science Society of America and American Society of Agronomy, Madison; 1986.
6. Yoder RE. A direct method of aggregate analysis and study of the physical nature of erosion losses. J. Agron. 1936;28:337-351.
7. Jackson ML. Soil chemical analysis. Prentice Hall of India Ltd., New Delhi; 1973.
8. Casida, L. E. Microbial metabolic activity in soil as measured by dehydrogenase determinations. Appl. Environ. Microbiol. 1977;34:630-636.
9. Wright, S. F., Upadhyaya, A. Extraction of an abundant and unusual protein from soil and comparison with hyphal protein from arbuscular mycorrhizal fungi. Soil Sci. 1966;161:575-586.
10. FAI [Fertilizer Association of India]. The Fertilizer (control) order, (1985). 2017. Accessed 22 August; 2022. Available: http://www.astaspice.org/food-safety/astas-analytical-methods-manual.
11. AOAC [Association of official analytical chemists]. Official methods of analysis. 16th edn. Association of official analytical chemists. Washington. DC; 1985.
12. Reeuwijik LPV, Nitrogen. In: Reeuwijik, LPV. editors. Procedures for Soil Analysis. 6th ed. International soil reference and Information Centre, The Netherlands; 2002.
13. Tan KH. Soil sampling, preparation and analysis, Marcel Dekker, New York; 1996.
14. Hamkalo Z, Bedernicheck T. Total, cold and hot water extractable organic carbon in soil profile: impact of land-use change. Zemdirbyste-Agriculture. 2014;101:125-132.
15. Kong X, Dao TH, Qin J, Li C, Zhang F. Effects of soil texture and land use interactions on organic carbon in soils in North China cities urban fringe. Geoderma. 2009;154 86-92.
16. Sihi D, Dari B, Sharma DK, Pathak H, Nain L, Sharma OP. Evaluation of soil health in organic vs. conventional farming of basmati rice in North India. J. Soil Sci. Plant Nutr. 2017;180:389-406.
17. Colla G, Mitchell JP, Joyce BA, Huyck LM, Wallender WW, Temple SR et al. Soil physical properties and tomato yield and quality in alternative cropping systems. J. Agron. 2000;92: 924-932.
18. Bhogal A, Nicholson FA, Chambers BJ. Organic carbon additions: Effects on soil bio-physical and physico-chemical properties. Eur. J. Soil Sci. 2009;60:276-286.
19. Gerhardt RA. A comparative analysis of the effects of organic and conventional farming systems on soil structure. Biol. Agric. Hortic. 1997;14:139-157.
20. Brady NC. The Nature and Properties of Soils. Macmillan Publishing Company; New York; 1990.
21. Lynch JM, Bragg E. Microorganisms and soil aggregate stability. In: B.A. Stewart, editors. Advances in Soil Science. Springer-Verlag; New York; 1985.
22. Suja G, Byju G, Jyothi AN, Veena SS, Sreekumar J. Yield quality and soil health under organic versus conventional farming in taro. Sci. Hortic. 2017;218: 334-343.
23. Kaje VV, Sharma DK, Shivay YS, Jat SL, Bhatia A, Purakayastha TJ *et al.* Long-term impact of organic and conventional farming on soil physical properties under rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system in north-Western Indo-Gangetic plains. Indian J. Agric. Sci. 2018;88:107-113.
24. Suja G, Sundaresan S, John KS, Sreekumar J, Misra RS. Higher yield, profit and soil quality from organic farming of

elephant foot yam. Agron. Sustain. Dev. 2012;32:755-764.

25. Stockdale EA, Lampkin NH, Hovi M, Keatinge R, Lennartsson EKM, Macdonald DW *et al.* Agronomic and environmental implications of organic farming systems. Adv. Agron. 2001;70: 261-327.
26. Papadopoulos A, Bird NRA, Whitmore AP, Mooney SJ. Investigating the effects of organic and conventional management on soil aggregate stability using X-ray computed tomography. Eur. J. Soil Sci. 2009;60:360-368.
27. Green VS, Cavigelli MA, Daos TH, Flanagan DC. Soil physical properties and aggregate-associated C, N and P distributions in organic and conventional cropping systems. Soil Sci. 2005;170:822-831.
28. Milne RM, Haynes RJ. Soil organic matter, microbial properties and aggregate stability under annual and perennial pasture. Biol. Fertil. Soils. 2004;39:172-178.
29. Velmourougane K. Impact of organic and conventional systems of coffee farming on soil properties and culturable microbial diversity. Sci. 2016;47:1-9.
30. Ramesh P, Panwar NR, Singh AB, Ramana S, Yadav SK, Shrivastava R *et al.* Status of organic farming in India. Curr. Sci. 2010;98:1190-1194.
31. Eghball B. Soil properties as influenced by phosphorus and nitrogen based manure and compost application. J. Agron. 2002; 94:128-135.
32. Ozlu E, Kumar S. Response of soil organic carbon, pH, electrical conductivity, and water stable aggregates to long term annual manure and inorganic fertilizer. Soil Sci. Soc. Am. J. 2018;82: 1243-1251.
33. Suja G. Comparison of tuber yield, nutritional quality and soil health under organic versus conventional production in tuberous vegetables. Indian J. Agric. Sci. 2013;83:1153-1158.
34. Reganold, J. P. Comparison of soil properties as influenced by organic and conventional farming systems. Am. J. Alt. Agric. 1988;3:144-155.
35. Gao G, Chang C. Changes in CEC and particle size distribution of soils associated with long-term annual application of cattle feedlot manure. Soil Sci. 1996;161:115–120.
36. Srivastava V, Araujo A, Vaish B, Bartelt-Hunt S, Singh P, Singh R. Biological response of using municipal solid waste compost in agriculture as fertilizer supplement. Reviews in Environmental Science and Bio/Technology. 2015;154: 142-151.
DOI: 15. 10.1007/s11157-016-9407-9.
37. Gu Y, Wang P, Kong CH. Urease, invertase, dehydrogenase and polyphenoloxidase activities in paddy soil influenced by allelopathic rice variety. Eur. J. Soil Biol. 2009;45:436-441.
38. Salazar S, Sanchez L, Alvarez J, Valverde A, Galindo P, Igual J *et al.* Correlation Among Soil Enzyme Activities Under Different Forest System Management Practices. Ecol. Eng. 2011;37:1123–1131.
39. Sheoran HS, Phogat VK, Dahiya, R., Gera, R. Long-term effect of organic and conventional farming practices on microbial biomass carbon, enzyme acivities and microbial populations in different textured soils of Haryana state (India). Appl. Ecol. Environ. Res. 2018;16:3669-3689.
40. Jean HB, Brian LA, Sharon YS, David JB. Soil microbial community variation correlates most strongly with plant species identity, followed by soil chemistry, spatial location and plant genus, AoB PLANTS. 2015;30(3):154-168.
41. Lee JE, Eom AH. Effect of organic farming on spore diversity of Arbuscular Mycorrhizal fungi and glomalin in soil. Mycobiology. 2019;37:272-276.
42. Kobierski M, Lemanowicz J, Wojewodzki P, Maciejewska KK. The effect of organic and conventional farming systems with different tillage on soil properties and enzymatic activity. Agron. 2020;10:1-13.
43. Zhang X, Wu X, Xing Y, Wang R, Liang W. Organic amendment effects on aggregate-associated organic carbon, microbial biomass carbon and glomalin in agricultural soils. Catena. 2014;123:188-194.
44. Melero S, Porras JCR, Herencia JF, Madejon, E. Chemical and biochemical properties in a silty loam soil under conventional and organic management. Soil Tillage Res. 2006;90:162-170.
45. Pulleman M, Jongmans A, Marinissen J, Bouma, J. Effects of organic versus conventional arable farming on soil structure and organic matter dynamics in a marine loam in the Netherlands. Soil Use Manag. 2003;19:157-165.
46. Shepherd M, Pearce B, Cormack B, Philipps L, Cuttle S, Bhogal A *et al.* An

assessment of the environmental impacts of organic farming. Agricultural Research Journal. 2003;56:78-98.
47. Greeshma PR. Assessment of soil health and status of heavy metals in the certified organic farms of Kerala. M. Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur; 2019.
48. Reganold JP, Palmer AS, Lockhart JC, Macgregor AN. Soil quality and financial performance of biodynamic and conventional farms in New Zealand. Sci. 1999;260:344-349.
49. Santos VB, Araujo ASF, Leite LFC, Nunes AAPL, Melo WJ. Soil icrobial biomass and organic matter fractions during transition from conventional to organic farming systems. Geoderma. 2012;170: 227-231.
50. Guimaraes DV, Gonzaga MIS, da Silva TO, da Silva TL, Dias NS, Matias MIS. Soil organic matter pools and fractions in soil under different land uses. Soil Tillage Res. 2013;126:177-182.
51. Araya-Alman, M., Olivares, B., Acevedo-Opazo, C. et al. Relationship Between Soil Properties and Banana Productivity in the Two Main Cultivation Areas in Venezuela. J. Soil Sci. Plant Nutr. 2020;20(3):2512-2524.
Available:https://doi.org/10.1007/s42729-020-00317-8
52. Lobo D, Olivares B, Rey JC, Vega A, Rueda-Calderón A. Relationships between the Visual Evaluation of Soil Structure (VESS) and soil properties in agriculture: A meta-analysis. Scientia agropecuaria. 2023;14 – 1:67-78.
Available:https://doi.org/10.17268/sci.agropecu.2023.007
53. Olivares BO, Calero J, Rey JC, Lobo D, Landa BB, Gómez JA. Correlation of banana productivity levels and soil morphological properties using regularized optimal scaling regression. Catena. 2022;208:105718.
Available:https://doi.org/10.1016/j.catena.2021.105718
54. Olivares B. Description of soil management in agricultural production systems in the Hamaca de Anzoátegui sector, Venezuela. La Granja: Revista de Ciencias de la Vida. 2016;23(1): 14–24.
Available:https://n9.cl/ycp08
55. Olivares B, Verbist K, Lobo D, Vargas Ry Silva O. Evaluation of the USLE model to estimate water erosion in an Alfisol. J. Soil Sci.and Plant Nutri. Chile. 2011;11(2):71-84.
Available:http://dx.doi.org/10.4067/S0718-95162011000200007
56. Olivares BO, Rey JC, Perichi G, Lobo D. Relationship of Microbial Activity with Soil Properties in Banana Plantations in Venezuela. Sustain. 2022;14,13531.
Available:https://doi.org/10.3390/su142013531
57. Campos BO. Banana Production in Venezuela: Novel Solutions to Productivity and Plant Health. Springer Nature; 2023.
Available:https://doi.org/10.1007/978-3-031-34475-6
58. Olivares B, Rey JC, Lobo D, Navas-Cortés J. A, Gómez J. A, Landa B. B. Machine learning and the new sustainable agriculture: applications in banana production systems of Venezuela. Agric. Res. Updates. 2022;42:133-157.
59. Rodríguez MF, Olivares B, Cortez A, Rey JC, Lobo D. Natural physical characterization of the indigenous community of Kashaama for the purposes of sustainable land management. Acta Nova. 2015;7(2):143-164.
Available:https://n9.cl/hakdx
60. Rodríguez-Yzquierdo G, Olivares BO, Silva-Escobar O, González-Ulloa, A, Soto-Suarez M, Betancourt-Vásquez M. Mapping of the susceptibility of Colombian musaceae lands to a deadly disease: *Fusarium oxysporum* f. sp. *cubense* tropical race 4. Hortic. 2023;9:757.
Available:https://doi.org/10.3390/horticulturae9070757
61. Hernández R, Olivares B. Application of multivariate techniques in the agricultural land's aptitude in Carabobo, Venezuela. Trop. Subtrop. Agroecosystems. 2020; 23(2):1-12.
Available:https://n9.cl/zeedh
62. Hernández R, Olivares B, Arias A, Molina JC, Pereira Y. Agroclimatic zoning of corn crop for sustainable agricultural production in Carabobo, Venezuela. Revista Universitaria de Geografía. 2018;27(2): 139-159.
Available:https://n9.cl/l2m83
63. Hernandez R, Olivares B, Arias A, Molina JC, Pereira Y. Eco-territorial adaptability of tomato crops for sustainable agricultural production in Carabobo, Venezuela. Idesia. 2020;38(2):95-102.

Available:http://dx.doi.org/10.4067/S07183429202 0000200095

64. Hernández R, Olivares B, Arias A, Molina JC, Pereira Y. Identification of potential agroclimatic zones for the production of onion *(Allium cepa* L.) in Carabobo, Venezuela. J. Selva Andina Biosp. 2018; 6(2):70-82. Available:http://www.scielo.org.bo/pdf/jsab/v6n2/v6n2_a03.pdf

65. Hernández R. Olivares B. Ecoterritorial sectorization for the sustainable agricultural production of potato (*Solanum tuberosum* L.) in Carabobo, Venezuela. Agric. Sci. Tech. 2019;20(2): 339-354. Available:https://doi.org/10.21930/rcta.vol20_num2_art:1462

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