

## Original Research Article

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

**Comment [SS1]:** It's better if the title doesn't use the location name specifically

### 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 agro-ecological zones of Kerala and were analyzed 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.

**Methodology:** Soil samples were collected from these farms and analyzed for soil physical, chemical and biological properties, total organic carbon, total nitrogen, C: N ratio and organic matter fractions.

**Results:** Organic farms exhibited lower bulk density ( $1.15 \text{ Mg m}^{-3}$ ) 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 found to be higher in electrical conductivity ( $0.09 \text{ dS m}^{-1}$ ), cation exchange capacity ( $5.98 \text{ C mol(p}^+) \text{ kg}^{-1}$ ), 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: agro ecological 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]. 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 environment. Introduction of organic farming is a solution mitigate these problems which 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].

The concept of organic farming is gaining gradual impetus in Kerala and certified organic farms are increasing to supply safe food as well to reduce environmental pollution. Kerala's rich endowments of wide variety of agricultural 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. MATERIAL AND METHODS

A field survey was conducted and ten pairs of certified organic farms and nearby conventional farms were identified from different agro ecological 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 during December 2020. The study was conducted during 2020-2021. Two composite samples were taken from each farm, shade dried and was 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]. 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].

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<sub>2</sub>SO<sub>4</sub>. 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 (texture of most of the selected farms was sandy loam). Fine particles have a greater ability to sequester carbon [15].

**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      |                     |
|                    | Clay (%)                            | 12.60      | 10.00               |
|                    | Class                               | Loam       | 10.80<br>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 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  $1.15 \text{ Mg m}^{-3}$  and for conventional farming system the mean value was  $1.27 \text{ Mg m}^{-3}$ . This difference in bulk density between organic and conventional systems were 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]. [18] reported that an addition of around  $65 \text{ t ha}^{-1}$  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 which 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].

**Comment [SS2]:** It can be explained the effect of increasing water holding capacity on plant growth

**Table 2.** Effect of soil properties on soil physical properties

| Sampling locations | Bulk density ( $\text{Mg m}^{-3}$ ) |              | Porosity (%) |              | Water holding capacity (%) |              |
|--------------------|-------------------------------------|--------------|--------------|--------------|----------------------------|--------------|
|                    | Organic                             | Conventional | Organic      | Conventional | Organic                    | Conventional |
|                    |                                     |              |              |              |                            |              |

|                          |               |           |                 |             |                 |             |
|--------------------------|---------------|-----------|-----------------|-------------|-----------------|-------------|
| Knr1-<br>Kiliyanthara    | 1.03          | 1.10      | 43.82           | 40.00       | 57.77           | 37.50       |
| Knr 2 -<br>Kiliyanthara  | 1.27          | 1.27      | 36.50           | 23.80       | 44.31           | 32.32       |
| Knr 3 -<br>Kootupuzha    | 1.23          | 1.19      | 32.91           | 33.88       | 55.55           | 32.29       |
| Wynd 1 -<br>Kabanigiri   | 1.25          | 1.34      | 47.92           | 33.00       | 85.71           | 18.34       |
| Wynd 2 -<br>Pulpalli     | 1.21          | 1.26      | 49.58           | 24.40       | 35.84           | 27.88       |
| Wynd 3 -<br>Mullankolli  | 1.01          | 1.08      | 39.40           | 43.15       | 37.89           | 36.17       |
| Pkd 1 -<br>Kanjirappuzha | 1.26          | 1.38      | 24.40           | 31.00       | 64.28           | 38.09       |
| Pkd 2 -<br>Kanjirappuzha | 0.95          | 1.25      | 48.18           | 31.82       | 51.80           | 32.71       |
| Pkd 3 -<br>Kanjirappuzha | 1.14          | 1.48      | 43.00           | 26.00       | 48.38           | 45.12       |
| Tvm 1 -<br>Vellayani     | 1.15          | 1.37      | 47.53           | 39.08       | 45.23           | 40.00       |
| Range                    | 0.95-<br>1.27 | 1.08-1.48 | 24.40-<br>49.58 | 23.80-43.15 | 35.84-<br>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<br>(P=.05)       | .037          |           | .017            |             | .002            |             |

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 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].

**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                        |              |

### 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]. [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<sup>-1</sup> and for conventional farms 0.03 - 0.15 dS m<sup>-1</sup>. The mean value for electrical conductivity was higher for organic farms (0.09 dS m<sup>-1</sup>). A high EC value was reported by [30] in the organic soils (1.74 dS m<sup>-1</sup>) than the conventional farms (1.18 dS m<sup>-1</sup>) of Kerala. [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. [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<sup>+</sup>) kg<sup>-1</sup> and 3.10-7.50 C mol (p<sup>+</sup>) kg<sup>-1</sup> 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].

**Comment [SS3]:** explain how the CEC is related to plant growth

**Table 4.** Effect of organic farming on chemical properties

| Sampling locations    | Soil pH |              | Electrical conductivity (dSm <sup>-1</sup> ) |              | Cation exchange capacity (C mol(p <sup>+</sup> ) kg <sup>-1</sup> ) |              |
|-----------------------|---------|--------------|--|--------------|---|--------------|
|                       | 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         |

|                      |               |           |               |           |               |           |
|----------------------|---------------|-----------|---------------|-----------|---------------|-----------|
| a                    |               |           |               |           |               |           |
| Tvm 1 -<br>Vellayani | 5.16          | 5.54      | 0.20          | 0.10      | 6.80          | 4.50      |
| Range                | 4.60-<br>6.96 | 5.05-6.76 | 0.04-<br>0.20 | 0.03-0.15 | 4.20-<br>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<br>(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  $25.21 \mu\text{g TPF g}^{-1} \text{ soil } 24 \text{ h}^{-1}$  and in conventional farms, the values was  $14.26 \mu\text{g TPF g}^{-1} \text{ soil } 24 \text{ h}^{-1}$ . 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  $9.47\text{-}19.07 \text{ mg g}^{-1}$  (mean  $12.31 \text{ mg g}^{-1}$ ) and in conventional farms  $3.50\text{-}9.58 \text{ mg g}^{-1}$  (mean  $6.18 \text{ mg g}^{-1}$ ). 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].

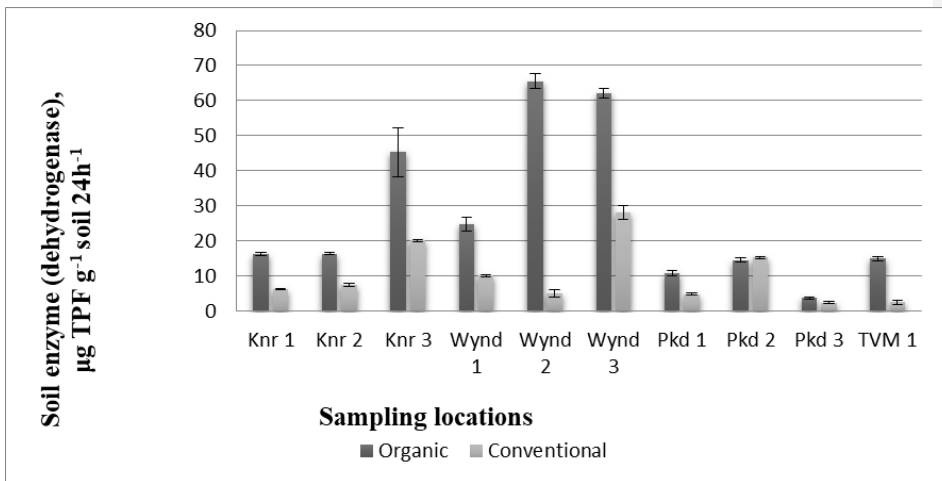


Fig 1. Effect of organic farming on soil enzyme (dehydrogenase),  $\mu\text{g TPF g}^{-1}\text{ soil } 24\text{h}^{-1}$

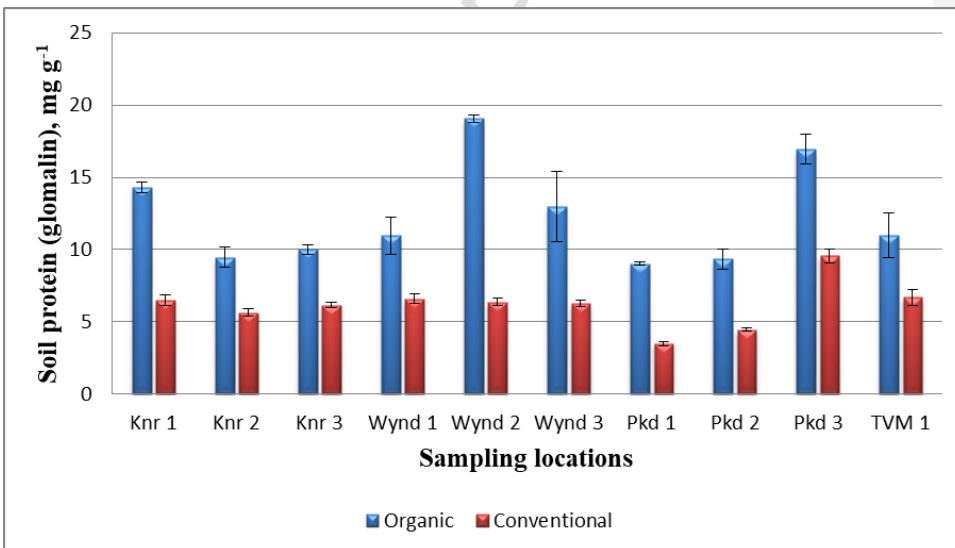


Fig 2. Effect of organic farming on soil protein (glomalin),  $\text{mg g}^{-1}$

### 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]. [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.

**Comment [SS4]:** Compare this with organic carbon which is suitable for plant growth

### 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 0.20-0.52% (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].

**Comment [SS5]:** It needs to be linked to soil nitrogen levels that are suitable for plants

### 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.

**Comment [SS6]:** What C/N ratio is appropriate for plant growth? Compare!

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         |              |

### 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 6 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

**Comment [SS7]:** It is necessary to explain the advantages of a higher fraction organic matter fraction in organic farming

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].

**Table 6.** Effect of organic farming organic matter fractions

| Sampling locations    | Fulvic acid (%) |              | Humic acid (%) |              | Humins (%) |              |
|-----------------------|-----------------|--------------|----------------|--------------|------------|--------------|
|                       | 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       |              |

#### 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.

**Comment [SS8]:** It is necessary to add an explanation about role of organic farming

**Comment [SS9]:** This statement is not related to the research objectives

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