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# Potential of Cropping Sequences on Soil Carbon Sequestration

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***Abstract: A research work was initiated during 2016-17 to assess the different cropping sequences on soil carbon sequestration in a Cauvery delta zone of Tamil Nadu. The different cropping sequences were $T_1$ (green manure- rice – black gram (relay crop), $T_2$ (GM - Rice- Sesame), $T_3$ (GM - Rice + Daincha - Maize + Green gram),$T_4$ (GM- Rice + Daincha – Bhendi),$T_5$(GM- Rice + Daincha – Ragi),$T_6$ (GM- Rice + Daincha – Varagu), $T_7$ (GM - Rice + Daincha – Fodder Cowpea). From the study, higher sequestration was recorded under the $T_3$ cropping sequences (0.36 t $ha^{-1}$) and also the higher soil carbon pools were seen as well as the legume included maize based cropping sequences. Hence the inclusions of legume in the maize based cropping sequences leads to sequestrate more carbon in the deltaic zone of Tamil Nadu.***
***Keywords: Cropping sequences, Soil carbon pools, Carbon sequestration, Legume, Cauvery delta zone***

## Introduction

Now a day the attention about the carbon sequestration in the soil has been increased due to the increasing concentration of carbon dioxide level in the atmosphere. Hence the global agreement made and accepted by the many countries at conference of parties 21 in Paris to reduce the global temperature by 2°C compared to pre industrial era by adopting the 4 per milli concept. However in the tropical areas sequestration carbon is the major problem due to high temperature. Current scenario the 40% of the planet area was converted into crop land (Lal, 2016) and considered as a vast global carbon sink. Adopting the crop rotation, usage of organic manure and the inorganic fertilizers, different tillage practices and the other cropping system components could maintain the soil organic carbon optimally in the soil (Huggins *et al*., 1998a; Janzen *et al.*, 1997; Swarup, 1998; Purakayastha *et al.*, 2008). Among this different management acquiring the appropriate cropping system could increase the soil organic carbon stock in the agriculture soil (Swarup *et al.,* 2000; Lal, 2002). There is a paucity of information available about the impact of cropping sequences on soil carbon sequestration and carbon pool in semi arid region. Under the crop intensification (Handayani *et al.*, 2002) 3 to 5 times increased addition of biomass and sequestrated more carbon than the continuous mono cropping (Rajput *et al.*, 2015). Liu *et al.* (2006) found that, the rice crop has high ability of sequestering more carbon 401 kg C $ha^{-1}$ $yr^{-1}$ (Jarecki and Lal, 2003). Among the different fodders, sequestration potential of carbon was higher in fodder grasses followed by fodder cereal and fodder legumes in forms of both below ground and above ground carbon removal (Bama and Babu, 2016). Carbon sequestration in the soil would affect the soil carbon pool which consists of active and passive pool. Different forms of SOC were showing varied degrees of sensitivity to management. Certain pools were more sensitive than total organic C (TOC) (Carter *et al.*, 1998; Von Lutzow *et al.*, 2002). such as labile carbon (Tirol-Padre and Ladha, 2004), soil microbial biomass C(MBC) mineralizable C (CMIN), POC, oxidizable carbon fraction (Chan *et al.*, 2001).

Within the different fractions of the soil organic carbon, water soluble carbon is the smallest fraction and it originated from the root exudation, dissolution of the leaf residues and from the soil colloidal complex (Mcgill *et al.*, 1986). and it was observed higher amount under the maize based cropping sequences (Brar *et al.*, 2015) and inclusion of legume in the cropping sequence (sunnhemp-chillies-sunflower) (Bama and Somasundaram, 2017) compared to other cropping sequences. These water soluble carbon acts as a food source to microbes which is present in the soil. The high activity of microbial population leads to increase the microbial biomass carbon. Smyrna (2016) reported that bhendi-maize+cowpea-sunflower had higher amount of microbial population and microbial biomass carbon compared to other cropping sequence.

The lowest microbial quotients were observed in annual crops and pastures. This indicated that microbial biomass was under stress, it was mainly based on the quality and quantity of available crop residues (Signor *et al.*, 2018). Inclusion of legumes promotes particulate organic matter (Barrios *et al.*, 1996) more by decomposition and root regeneration due to additional N, which may improve root contributions. Left over root biomass and the microbial biomass debris act as a major sources of POC. Puget and Drinkwater (2001) reported that the POC was increased with increasing root biomass. According to Blair *et al.* (1995) and Chan *et al.* (2001), the addition of crop residue under the management systems led to increase the organic matter content in soil which increased the very labile (F1) fraction.

The study hypothesized that inclusion of legume in the cropping sequences may increase soil the carbon pools which in turn affect the carbon sequestration and in different forms. Hence, to determine the changes in WSC, MBC, SOC, POC, labile carbon and its fraction by the different cropping sequences and to assess the sequestration of C in the soil the study was initiated.

## Materials and Methods

The study was initiated at the Soil and Water Management Research Institute, Thanjavur the Cauvery Delta Zone of Tamil Nadu to investigate the impact of different cropping sequences on the soil carbon sequestration and soil carbon pools. To cater the needs of the study, soil samples were collected from already existing experiment (after completing one sequence) which comprises of seven different cropping sequences viz.,$T_1$(green manure- rice – blackgram (relay crop),$T_2$ (GM - Rice- Sesame),$T_3$(GM - Rice + Daincha - Maize + Green gram),$T_4$ (GM- Rice + Daincha – Bhendi),$T_5$(GM- Rice + Daincha – Ragi),$T_6$ (GM- Rice + Daincha – Varagu), $T_7$ (GM - Rice + Daincha – Fodder Cowpea and analysed for soil carbon pools and assesses the carbon sequestration potential.

The experimental soil comes under Alfisol, sandy loam texture and belongs to madukur soil series (Typic Haplustalf). Bulk density of the soil ranged from 1.36 to 1.38 Mg $m^{-3}$.Porosity of the soil ranged from 35.8 to 41.6 %.The available water content was varied from 3.98-4.86%. The pH of the soil ranged from 6.30 to 6.40 (slightly acidic).The range of EC was 0.14-0.15 $dSm^{-1}$. The CEC of the soil was ranged from 9.7 to13.8 (C mol ($P^+$) $kg^{-1}$). With respect to soil nutrients soil available nitrogen ranged from 217-258 kg $ha^{-1}$, phosphorus from 19 to 30 kg $ha^{-1}$, potassium from 78 to 102 kg $ha^{-1}$.The soil carbon content was varied from 5.60 to 7.03 g $kg^{-1}$.The highest labile carbon, water soluble carbon, microbial biomass carbon content were noticed in $T_3$ cropping sequence 0.91 g $kg^{-1}$, 34 mg $kg^{-1}$, 245 mg $kg^{-1}$ respectively. Among the different cropping sequence the highest recalcitrant present in $T_3$ cropping sequence (2.76 g $kg^{-1}$).The particulate organic matter content varied from 1.33 to 3.26 g $kg^{-1}$. The details of different soil carbon pools, biomass carbon removal, carbon management index and soil carbon stock was worked out are given below.

**Procedure for Soil Carbon Pools**

The soil samples passed through 2mm sieve is used for soil carbon pool estimation. Water soluble carbon (WSC) was determined using the method as described by Mcgill *et al.* (1986). Microbial biomass carbon (MBC) was determined by the fumigation-extraction method (Vance *et al.*, 1987).Microbial quotient was calculated by using this formulae MBC/SOC. Labile carbon estimated as potassium permanganate oxidizable carbon was done by modified method of Weil and Magdoff (2004).

$$\text{Active C (mg/kg)} = \frac{[0.02\text{M}/\text{l} - (\text{concentration}) * (9000\text{mgC}/\text{M}) * (0.02\text{l solution})}{0.005\text{Kg soil}}$$

Particulate organic carbon (POC) was determined using the method as described by Cambardella and Elliott (1992). Fifty gram of 2mm sized soil samples were dispersed in 150 ml of 0.5 % sodium hexametaphosphate solution by shaking for 12hrs on a reciprocal shaker. The dispersed soil sample was passed through 250 and 53 µm sieves. After rinsing several times with water the material that retained on the sieves 53 µm was collected in a beaker and dried at 50°C for overnight. The dried samples were ground and analysed for total carbon by Walkey and Black rapid titration method as POC.

Oxidizable organic carbon fraction was determined through a modified Walkey and Black's (1934) method as described by Chan *et al.* (2001) using $H_2SO_4$ solution ratios of 0.5:1, 1:1&2:1(which correspond to 12N, 18N, 24N $H_2SO_4$ respectively).The amount of SOC determined using the three acid –aqueous solution ratios allows transformation of total organic C into the following four fractions of decreasing oxidizability/lability.

Fraction 1(very labile) : Organic C oxidizable under 12N $H_2SO_4$

Fraction 2(labile): Difference in oxidizble organic C extracted between 18N & 12N $H_2SO_4$

Fraction 3(less labile): Difference in oxidizble organic C extracted between 24N & 18N $H_2SO_4$

Fraction 4(recalcitrant): Residual oxidizble organic C after reaction with 24N $H_2SO_4$ when compared with the TOC.

**Recalcitrant Index**

Ratio between the labile to recalcitrant showed the predominant form of the carbon present in the soil (The value less than one indicate high labile nature of the C and more than 1 indicate predominant form of the carbon was recalcitrant).

**Carbon Management Index**

Carbon management index (CMI) = CPI*LI*100

Carbon pool index (CPI) = $\frac{\text{TOC sample soil}}{\text{TOC reference soil}}$

Lability of carbon(LC) = $\frac{\text{C in fraction oxidized by KMnO}_4}{\text{C remaining unoxidized by KMnO}_4}$

Lability index(LI) = $\frac{\text{LC of sample soil}}{\text{LC of reference soil}}$

**Procedure for Biomass Carbon Determination**

**Above Ground Biomass**

Based on the yield data of above ground biomass and on dry weight basis carbon removal was calculated for the different cropping sequences by multiplying with 0.45(45% of C in drymatter).

**Below Ground Biomass**

Based on the root weight of the below ground biomass of plant, carbon removal was calculated for the different cropping sequences by multiplying with 0.45(45% of C).

**Soil Carbon Stock**

Soil organic carbon stock was calculated using the concentration of the total soil organic carbon in % (TOC), depth (cm) and bulk density ($Mgm^{-3}$) of each layer (Sisti *et al.*, 2004).

$$\text{C stock (t ha}^{-1}\text{)} = \text{TOC*BD*D}$$

**Result and Discussion**

**Water Soluble Carbon (WSC)**

In kharif season $T_3$ cropping sequence recorded higher amount of WSC (57.1 mg $kg^{-1}$) which was comparable with $T_1$ (54.3 mg $kg^{-1}$). In the rabi season, $T_3$ had the higher amount of WSC (69.5 mg $kg^{-1}$) which was on par with $T_1$ (68.2 mg $kg^{-1}$) and $T_7$ (64.7 mg $kg^{-1}$). In the summer season higher amount of WSC present under the $T_3$ cropping sequence (43.1 mg $kg^{-1}$) which was on par with $T_7$ (42.7 mg $kg^{-1}$) and $T_1$ (42.3 mg $kg^{-1}$) . Among the three seasons, the rabi season recorded higher water soluble carbon (Table 1) might be due to the cold weather and in turn slow decomposition of organic matter. Incorporation of green manure (fresh OM) in to the soil increased the microbial activity which increases the decomposition of the SOM and the water soluble carbon. This was agreed by Kaur *et al.* (2008), Manna *et al.* (2006) and Yagi *et al.* (2005).

**Microbial Biomass Carbon (MBC)**

The significant difference of MBC was observed among the cropping sequence in the soil (Table 1). In kharif, rabi and summer seasons the range of microbial biomass carbon was (201 to 265 mg $kg^{-1}$), (294 to 224 mg $kg^{-1}$) and (248 to 131 mg $kg^{-1}$) respectively.$T_3$ recorded higher value across all the season as well as the on par with $T_7$ cropping sequence. Among the seasons rabi seasons has the greater influence on microbial biomass carbon might be due to death of microbial population observed from kharif season and also low temperature leads to the buildup of organic matter in the present study during that season. The result is in line with Martens (1995).

Microbial quotient is the ratio of microbial biomass C to organic C which act as an indicator for the degree of disturbance of soil C cycling (Anderson and Domsch, 1993). With respect to cropping sequences $T_1$ cropping sequence recorded the high microbial quotient value (Table 1) revealed that less degree of disturbance. It might be due to black gram as the relay crop in the summer season. $T_4$ had the low ratio of microbial quotient which indicates the degree of disturbance of soil C cycle was high. A low ratio indicates a reduced pool of available C in soil (Klose *et al.*, 2004). It was supported by Signor *et al.* (2018) that the m quotient was low under the annual crops when compared it to pasture it may be due to the quality and quantity of crop residue which indicate that microbial biomass under stress.

## Soil Organic Carbon (SOC)

Influences of cropping sequences on SOC are well noticed during kharif, rabi and summer seasons. The soil organic carbon content was varied from (7.20 to 5.68 g $kg^{-1}$), (7.25 to 5.23 g $kg^{-1}$) and (7.18 to5.53 g $kg^{-1}$) respectively. The rabi season showed higher amount of SOC (Table 2) which is mainly due to the slow rate of decomposition during rabi (Watanabe, 1984) and lower organic carbon content in summer by high temperature and aerobic condition of the soil which might have influence the rate of mineralization and increase the turnover rate (Chander *et al.*, 1997) and ultimately SOC would have reduced.

## Labile Carbon

Compared to all season rabi season recorded higher amount of labile carbon (Table2) under $T_3$ (1.28 g $kg^{-1}$) cropping sequence which was on par with $T_7$ (1.23 g $kg^{-1}$). Lowest was recorded under $T_2$ cropping sequence (1.06 g $kg^{-1}$). The maintenance of the labile carbon might be high due to the cool climate as well as the lower mineralization rate during that season. This is in corroboration with Ghosh *et al.* (2016). Present study also showed $T_3$ cropping sequence had high amount of MBC, WSC, and microbial population and it might be the reason for high labile carbon content under the T3 cropping sequence.

 

## Particulate Organic Carbon (POC)

The result on fine fraction of POC of the soil (Table3) showed that the higher value was recorded under $T_3$ cropping sequence (4.03 g $kg^{-1}$) which was on par with $T_7$ (3.64g $kg^{-1}$) in the kharif season. Lowest was recorded under $T_4$ (2.59 g $kg^{-1}$) cropping sequence. In rabi season the high value of fine fraction of POC present under $T_3$ (5.08 g $kg^{-1}$) cropping sequence followed by $T_7$ (4.42 g $kg^{-1}$.In summer season, the $T_3$ treatment had highest amount of POC (fine fraction) among the different cropping sequence (5.01 g $kg^{-1}$) which was followed by $T_7$ (4.35 g $kg^{-1}$).It was mainly due to inclusion of legumes promotes particulate organic matter more by decomposition and root regeneration due to additional N, which may improve root contributions and left over root biomass and the microbial biomass debris act as major sources of POC. This is line with (Barrios *et al.*, 1996). Puget and Drinkwater (2001) reported that the POC was increased with increasing root biomass. Hence it might be the reason for the higher POC was recorded under $T_3$ cropping sequences in all the season.

## Oxidizable Organic Carbon Fraction

Soil samples collected from different cropping sequences and different seasons (kharif, rabi and summer) were analyzed for different oxidizable fraction. View on carbon sequestration recalcitrant fraction of oxidizable organic carbon play the vital role. Ratio between the labile to recalcitrant showed the predominant form of the carbon present in the soil (Fig 1) (The value less than one indicate high labile nature of the C and more than 1 indicate predominant form of the carbon was recalcitrant).Though recalcitrant form of the carbon present predominantly under all the cropping sequences due to having the value more than 1, $T_3$ possess the more amount carbon than the others. This is in corroboration with Barreto *et al.* (2011).

## Carbon Management Index

The CMI showed the influence of land use on the TOC levels. Values below or above 100 indicate either a negative or positive impact on TOC content. Among the cropping sequences the higher value of CMI recorded (Table 5) in $T_3$ (89.6) and least was in the $T_5$

(73.7).The carbon management index (CMI) indicates the influence of land use on the TOC levels. Values below or above 100 indicate either a negative or positive impact on TOC content and soil quality, (De Bona *et al.*, 2008). In the present study all the cropping sequences registered below 100 shows that all systems getting degraded. Comparatively among the cropping sequences $T_3$ registered high values and performs better in sustaining soil carbon. It might be due to organic residue addition come from the above ground biomass and below ground biomass crops. This is in agreement with Smyrna (2016).

**Carbon Sequestration Potential**

**Carbon Removal by the Above Ground Portion**

To calculate the $CO_2$ removal, the biomass yield (grain and straw yield) was used as a dry matter after converting fresh biomass to dry matter. The cropping sequences yield of the above ground portion was recorded for each harvest and converted to carbon removal (Table 4). Among the different cropping sequences, $T_3$ (green manure-rice+daincha-maize+greengram)showed the highest amount of carbon removal (25.3 t $ha^{-1}$) followed by $T_7$ (24.7 t $ha^{-1}$). Primarily, plants possessing C4 photosynthetic pathway are capable of fixing 60 to 80 mg of $CO_2$ $dm^{-2}$ $hr^{-1}$ while C3 plants produce 15 to 30 mg of $CO_2 dm^{-2}$ $hr^{-1}$ (Cooper and Tainton, 1968). The data suggest that the C4 plant species are ideal candidates for C sequestration process in the agricultural production system. In the present investigation also, C4 plant maize along with a C3 crop green gram intercropping ($T_3$) with maize (C4 crop) showed the high amount of C sequestration compared to the sole cropping of all other treatment. This is also in line with Smyrna (2016) that the bhendi-maize+cowpea-sunflower cropping sequence better is sequestering carbon.

**Carbon Removal by the Below Ground Portion**

The quantity of carbon removed by the below ground crops revealed that, among the cropping sequences $T_3$ (7.99 t $ha^{-1}$) was recorded highest below ground carbon yield followed by $T_7$ (7.27 t $ha^{-1}$) (Table 4).It might be due to the high amount of root biomass from maize

 

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intercropping with green gram. High fibrous root system along with fungus mat favoured high root biomass. This is in line with Kuzyakov and Domanski (2000) that 20 to 30% of total assimilated $CO_2$ was transferred into the soil through roots, root exudates of $CO_2$ by the crops. The C stored in root indicates that half of the C will remain in the root. One third portion was evolved as $CO_2$ from the soil by the root respiration and utilization by the microbial population. At last the remaining part of the C was added into the soil. The carbon associated with micro aggregates was more strongly attracted by the soil particles. In the present study also, POC mineral associated carbon, labile carbon and recalcitrant carbon was pronounced in $T_3$ treatment which might have improved the general performance of root growth of plants and in turn increase the carbon storage in soil.

**Soil Carbon Stock**

To quantify the soil organic matter stock in the soil the carbon percentage was converted to t $ha^{-1}$ by multiplying SOC with bulk density and soil depth (fig 2). Among the different cropping systems, $T_3$ sequestered 0.36 t $ha^{-1}$ of carbon followed by $T_7$ 0.20t $ha^{-1}$ and $T_1$ 0.18 t $ha^{-1}$showed the highest amount of soil carbon stock which might be due to biomass addition and recalcitrant carbon storage in particular cropping sequence of maize and green gram. These carbons associated with the micro aggregates and more protected from degradation and stored the carbon for longtime (Shrestha *et al.*, 2006). This might have contributed for more carbon stock in $T_3$.This is in line with Smyrna (2016) that (Bhendi-maize+cowpea-sunflower) cropping sequence record higher soil carbon stock.

**Conclusion**

Based on this study carried out to find out the influence of cropping sequence on soil carbon pool and carbon sequestration showed that the inclusion of legume in the maize based cropping sequence $T_3$ (Green manure-rice+daincha-maize+greengram) recorded higher SOC, MBC, LC ,WSC,POC. Same cropping sequence revealed the higher above ground biomass carbon and below biomass carbon, soil carbon stock and CMI and followed by $T_7$ (Green manure-rice+daincha-fodder cowpea) and $T_1$ (Green manure - rice- Black gram). However, higher value

 

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of microbial quotient was recorded under $T_1$ (Green manure - rice -black gram). The research recommends that, adoption of Green manure-rice+daincha-maize+greengram cropping sequences in the deltaic region of Tamil Nadu not only improve the soil fertility by improving soil carbon content and stock also by harvesting more carbon from the atmosphere by the way of sequestration. Alternatively the Green manure - rice -black gram also performs equally in soil carbon stock and plant biomass carbon removal, it could also be recommended to maintain soil health based on farmers feasibility.

**Table 1: Influences of different cropping sequences on carbon pools of the soil - I**

| Cropping sequence | Water soluble carbon (mg kg$^{-1}$) | | | Microbial biomass carbon (mg kg$^{-1}$) | | | M Quotient | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Kharif** | **Rabi** | **Summer** | **Kharif** | **Rabi** | **Summer** | **Kharif** | **Rabi** | **Summer** |
| $T_1$ | 54.3 | 68.2 | 42.3 | 233 | 259 | 230 | 3.85 | 4.25 | 3.81 |
| $T_2$ | 32.7 | 44.6 | 28.4 | 201 | 224 | 204 | 3.54 | 3.91 | 3.69 |
| $T_3$ | 57.1 | 69.5 | 43.1 | 265 | 294 | 248 | 3.68 | 4.06 | 3.45 |
| $T_4$ | 36.4 | 45.5 | 26.9 | 211 | 235 | 131 | 3.47 | 3.83 | 2.21 |
| $T_5$ | 43.9 | 59.5 | 37.9 | 211 | 241 | 166 | 3.45 | 3.91 | 2.79 |
| $T_6$ | 49.4 | 59.5 | 41.4 | 233 | 235 | 210 | 3.75 | 3.75 | 3.49 |
| $T_7$ | 51.3 | 64.7 | 42.7 | 243 | 270 | 236 | 3.55 | 3.92 | 3.46 |
| | | | | | | | | | |
| SEd | 1.92 | 2.73 | 2.40 | 11.7 | 8.99 | 18.2 | | | |
| CD (P=0.05) | 4.19 | 5.95 | 5.23 | 25.6 | 19.5 | 39.7 | | | |

$T_1$ - Sunnhemp - Rice - Blackgram , $T_2$ - Sunnhemp - Rice – Sesame, $T_3$ - Sunnhemp - Rice + Daincha - Maize + Green gram $T_4$ - Sunnhemp - Rice + Daincha - Bhendi , $T_5$ - Sunnhemp - Rice + Daincha – Ragi, $T_6$ - Sunnhemp - Rice + Daincha – Varagu, $T_7$ - Sunnhemp - Rice + Daincha - Fodder Cowpea

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**Table 2: Influences of different cropping sequences on carbon pools of the soil - II**

| Cropping sequence | Soil organic carbon (g $kg^{-1}$) | | | Labile carbon (g $kg^{-1}$) | | |
|---|---|---|---|---|---|---|
| | Kharif | Rabi | Summer | Kharif | Rabi | Summer |
| $T_1$ | 6.05 | 6.10 | 6.03 | 1.06 | 1.20 | 1.16 |
| $T_2$ | 5.68 | 5.73 | 5.53 | 0.98 | 1.06 | 0.95 |
| $T_3$ | 7.20 | 7.25 | 7.18 | 1.11 | 1.28 | 1.23 |
| $T_4$ | 6.08 | 6.13 | 5.93 | 0.88 | 1.10 | 0.94 |
| $T_5$ | 6.11 | 6.16 | 5.96 | 0.95 | 1.15 | 1.02 |
| $T_6$ | 6.21 | 6.26 | 6.01 | 0.98 | 1.20 | 1.08 |
| $T_7$ | 6.84 | 6.89 | 6.82 | 1.08 | 1.23 | 1.20 |
| | | | | | | |
| SEd | 0.39 | 0.38 | 0.45 | 0.05 | 0.06 | 0.08 |
| CD (P=0.05) | 0.84 | 0.82 | 0.97 | 0.12 | 0.12 | 0.18 |

$T_1$ - Sunnhemp - Rice - Blackgram , $T_2$ - Sunnhemp - Rice – Sesame, $T_3$ - Sunnhemp - Rice + Daincha - Maize + Green gram $T_4$ - Sunnhemp - Rice + Daincha - Bhendi , $T_5$ - Sunnhemp - Rice + Daincha – Ragi, $T_6$ - Sunnhemp - Rice + Daincha – Varagu, $T_7$ - Sunnhemp - Rice + Daincha - Fodder Cowpea

**Table 3: Influences of different cropping sequences on particulate organic carbon (g $kg^{-1}$)**

| Cropping sequence | 250-53 µm | | |
|---|---|---|---|
| | Kharif | Rabi | Summer |
| $T_1$ | 3.18 | 3.21 | 3.14 |
| $T_2$ | 2.94 | 3.04 | 2.92 |
| $T_3$ | 4.03 | 5.08 | 5.01 |
| $T_4$ | 2.59 | 2.94 | 2.82 |
| $T_5$ | 3.01 | 3.31 | 3.16 |
| $T_6$ | 3.17 | 3.75 | 3.62 |
| $T_7$ | 3.64 | 4.42 | 4.35 |
| SEd | 0.16 | 0.17 | 0.17 |
| CD(P=0.05) | 0.34 | 0.38 | 0.38 |

T1 - Sunnhemp - Rice - Blackgram , T2 - Sunnhemp - Rice – Sesame, T3 - Sunnhemp - Rice + Daincha - Maize + Green gram T4 - Sunnhemp - Rice + Daincha - Bhendi , T5 - Sunnhemp - Rice + Daincha – Ragi, T6 - Sunnhemp - Rice + Daincha – Varagu, T7 - Sunnhemp - Rice + Daincha - Fodder Cowpea

 

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**Table 4: Influences of different cropping sequences on Carbon management index**

| Cropping sequence | Carbon pool index | Lability of carbon | Lability index | Carbon management index |
|---|---|---|---|---|
| $T_1$ | 0.593 | 0.232 | 1.46 | 86.57 |
| $T_2$ | 0.551 | 0.213 | 1.34 | 74.03 |
| $T_3$ | 0.705 | 0.202 | 1.27 | 89.64 |
| $T_4$ | 0.591 | 0.203 | 1.28 | 75.66 |
| $T_5$ | 0.594 | 0.197 | 1.24 | 73.79 |
| $T_6$ | 0.602 | 0.215 | 1.36 | 81.65 |
| $T_7$ | 0.670 | 0.206 | 1.30 | 86.99 |

$T_1$ - Sunnhemp - Rice - Blackgram , $T_2$ - Sunnhemp - Rice – Sesame, $T_3$ - Sunnhemp - Rice + Daincha - Maize + Green gram $T_4$ - Sunnhemp - Rice + Daincha - Bhendi , $T_5$ - Sunnhemp - Rice + Daincha – Ragi, $T_6$ - Sunnhemp - Rice + Daincha – Varagu, $T_7$ - Sunnhemp - Rice + Daincha - Fodder Cowpea

**Fig.1. Recalcitrant index for different cropping sequences**

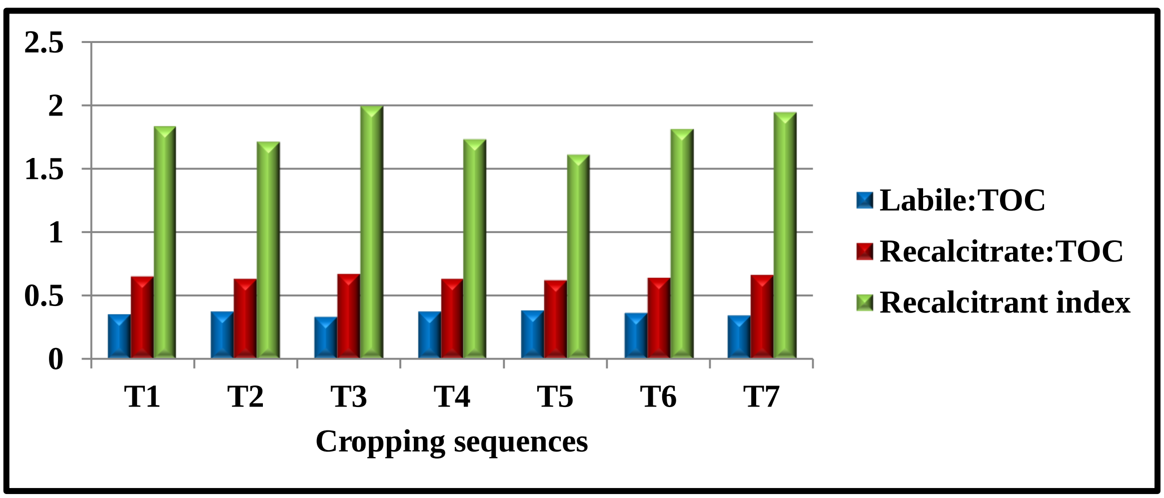
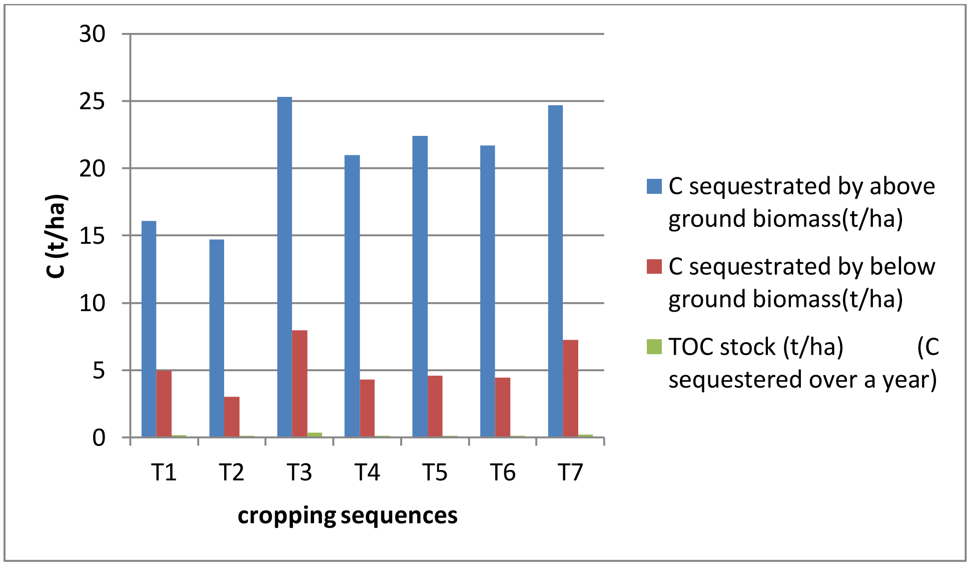


**Fig 2: Influences of different cropping sequences on Carbon sequestration**




$T_1$ - Sunnhemp - Rice - Blackgram , $T_2$ - Sunnhemp - Rice – Sesame, $T_3$ - Sunnhemp - Rice + Daincha - Maize + Green gram $T_4$ - Sunnhemp - Rice + Daincha - Bhendi , $T_5$ - Sunnhemp - Rice + Daincha – Ragi, $T_6$ - Sunnhemp - Rice + Daincha – Varagu, $T_7$ - Sunnhemp - Rice + Daincha - Fodder Cowpea

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