Carbon sequestration in the agricultural soils – Case study

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Abstract - *This overview paper concentrates to examine the magnitude of soil organic carbon that can be sequestered in agricultural sources in order to reduce their respective emissions. Agricultural sector also plays a major role in sequestering carbon dioxide in a relatively inexpensive way which helps in combating climate change.* ***GLOBAL CARBON SINKS*** *is a term well known for the forest and agriculture fields. But as the result of urbanization, deforestation and introduction of the chemical fertilizers, these* ***GLOBAL RECEPTORS*** *lost its native property. In this project, a survey is conducted to analyze the effect of carbon sequestration in the soil exposed to chemical and green fertilizers. The samples are collected at different locations and provided with chemical and bio fertilizers separately. Then the sequestering capacity is tested by standard procedure and Improving steps are analyzed. The results are manipulated in graphical methods.*

Key Words**: Carbon Dioxide Sequestration, Carbon Dioxide Mitigation, Land Use Changes, Soil Organic Matter (SOM).**

1.INTRODUCTION

The concentration of carbon dioxide and other green house gases in the atmosphere has considerably increased over the last century and is set to rise further. Human disturbance of the global carbon cycle occurs through the release of carbon dioxide into the atmosphere via changes in agricultural land-use, and forest transformations[2]. This perturbation encourages a complex response of the natural carbon pools and fluxes, which together result in an increased atmospheric carbon dioxide, the main cause of climate change.

Carbon sequestration has been suggested as a potential low-cost means to reduce atmospheric concentrations of GHGs. The Kyoto Protocol added further impetus on the development of carbon sequestration strategies[4]. Climate change is one of the serious issues at present. Agriculture sector plays major role in climate change since it emits large amount of greenhouse gases like carbon dioxide, methane and nitrous oxide.

Agricultural lands are believed to be a major potential sink and could absorb large quantities of carbon if woody shrubs and trees are reintroduced to these systems and judiciously managed together with soils, crops or animals. This has resulted in a need for a better understanding of the dynamics of the carbon cycle and the extent to which it can be managed to help stabilize atmospheric carbon dioxide concentrations.

1.1 Role of Agriculture in Carbon Sequestration

Agriculture occupies a larger portion of global land area than the other activities. Historically, carbon has been released from the soil as a result of converting land to cultivation. Various processes related to agricultural production, including soil erosion and leaching of agricultural chemicals lead to the release of soil carbon and other GHGs[3]. Forest, agricultural, rangeland, wetland, and urban landscape systems have significant potential for sequestering large amounts of carbon through improved land management practices and increasing productivity.

1.2 Objectives

The objective of this paper is to discuss the dynamics of soil organic carbon over a short period of time, along with the physico-chemical properties of organic and inorganic farming. Considerable research is also carried out to observe the changes of soil characteristics and its relationship with soil carbon. The impact of organic farming and conventional farming on soil organic status was also studied.

2. Background Information

2.1 Carbon Sequestration – Definition

Carbon sequestration is the process of capture and long term storage of atmospheric carbon dioxide[1]. It can also be defined as the mitigation of carbon or defer global warming and avoid dangerous climate change. Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids and in a form that is not immediately remitted.

2.2 Carbon and soil organic matter

Carbon is a key ingredient in soil organic matter (57% by weight). Soil organic matter is created by the cycling of organic compounds in plants, animals, and microorganisms into the soil[5]. Well-decomposed organic matter forms humus, a dark brown, porous, spongy material that provides carbon and energy source for soil microbes and plants. When soils are tilled, organic matter previously protected from microbial action is decomposed rapidly because of changes in water, air, and temperature conditions, and the breakdown of soil aggregates accelerates erosion. A soil with high organic matter is more productive than the same soil where much of the organic matter has been "burned" through tillage and poor management practices and transported by surface runoff and erosion. However, organic matter can be restored to about 60 to 70% of natural levels with best farming practices[6].

2.3 Study area description

The present study was carried out in Podhanoor and Onnampalayam which lies in Coimbatore.

3. Methodology

Comparative study of the soil from organic and conventional farming was carried out and the chemical properties of the soil like pH, organic carbon and nitrogen content was found. The study was carried out in two different places in the Coimbatore city. A farm near Podhanoor was selected for the sample collection from organic farm and a farm near Maruthamallai was selected for the sample collection from conventional farming system. The samples were collected in three locations from the same area. The duration for each sample was 15days for organic sample and 10 days for inorganic sample. Thus the study was carried out in short period of time. After the samples are collected it's then subjected to drying at room temperature. Drying is carried out for the purpose of removal of moisture content in the soil. After the soil is dried up completely sieving is carried out. The soil sample was sieved using the sieving machine of sieve size 75µm. Then the sample is analyzed using the standard methods.

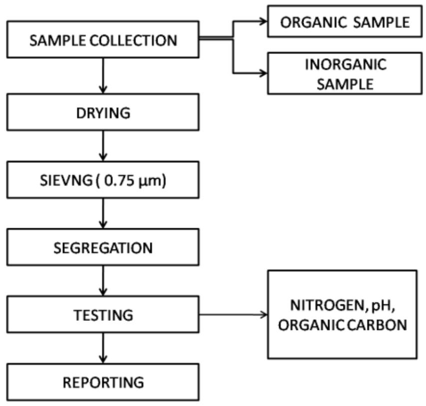

Fig -1: Experimental Process

3.2 Sample Collection

Collection of samples was carried out in Podhanoor (organic sample) and Onapalayam (inorganic sample). Both the samples were collected with the same duration organic and inorganic samples. The organic and inorganic sample collection was carried out with the duration of 10days in-between each sample. The collected sample was then subjected to certain process like drying, sieving and then testing of sample was carried out. Both the organic and inorganic samples were dried at room temperature for certain period. Drying was done in order to remove the moisture content in the samples.

Fig -2: Drying of collected samples

3.3 Sieving and testing of sample

The soil sample which was subjected to drying is then taken for sieving process. We carried out mechanical sieving, were the samples was dumped into the pan which has wire mesh attached to it. The sieve size chosen here is 0.75µm. as soon as the sample is dumped into the vessel it's kept in the mechanical shaker and the duration of 10 minutes is set-up. After 10 minutes the mechanical shaker automatically stops. The sieved sample is collected in separate pan. And the sieved sample is then taken for analysis.

Soil samples were tested in laboratory for following parameters - Ph Level, Carbon Content, Nitrogen Content.Part of the sample was taken from each different samples collected from various locations for the determination of pH, organic carbon, and nitrogen content and the remaining soil was put on a tray and was allowed to air-dry. Then soil was crushed with a mortar and pestle. The crushed soil was then passed through 75μm sieve and the screened soil was taken for the further analysis.

Fig -3: Sieving of sample

Table -1: methods adopted for soil parameter analysis

S.N	Parameters	Methods
1	pH	Digital pH meter
2	Organic carbon	Walkley and Black method
3	Total nitrogen	Kjeldahl method

4. Results and discussion

In the soil under farming system the organic content ranged from 0.545 to 2.538. The average organic content varied significantly between the locations 1.61, 2.027, 1.188. During the experimental period the organic content generally was found increasing in the location 1 as 1.531, 2.538 and 1.321 in 2 week's interval between each sample. However in all the locations the organic content was found decreasing by the fourth week. It was mainly due to the rainfall. It clearly shows that climatic conditions influence the carbon sequestration. The decrease in carbon capture shows that the microbial activity is triggered and the carbon is released into the atmosphere.

Table – 2: Parameters analyzed for organic sample

Sample 1	ph	Organic carbon%	Nitrogen (mg/kg)
Location 1	6.45	1.531	196
Location 2	6.53	2.307	112
Location 3	6.80	0.964	224
Sample 2			
Location 1	6.79	2.538	280
Location 2	6.88	2.139	168
Location 3	6.96	1.405	224
Sample 3			
Location 1	7.10	1.321	140
Location 2	6.80	1.699	140
Location 3	7.10	0.545	196

Table – 3: Parameters analyzed for inorganic sample

Sample 1	pH	Organic carbon%	Nitrogen (mg/kg)
Location 1	6.92	1.510	140
Location 2	6.38	1.384	364
Location 3	6.44	1.489	224
Sample 2			
Location 1	6.56	0.859	224
Location 2	6.70	1.678	504
Location 3	7.44	1.762	280

4.1 Soil carbon and nitrogen relationship

This 8-10:1 carbon: nitrogen ratio means that for every 8-10 lb of carbon sequestered in soil organic matter, 1 lb of nitrogen must accompany it. This tie-up of nitrogen reduces nitrogen for crops. For example, if a farmer adopted no-till that resulted in an increase of soil carbon of 0.45 ton/ac over 10 years, 0.045 t/ac (90lb) of applied nitrogen would have been tied up in soil organic matter and would not have been available to his crops. Legume crops such as alfalfa, peas, lentil sand chickpea could serve as alternative sources for nitrogen.

Table – 4: Organic carbon and nitrogen in organic sample

Sample 1	Organic carbon %	Nitrogen (mg/kg)
Location 1	1.531	196
Location 2	2.307	112
Location 3	0.964	224
Sample 2		
Location 1	2.538	280
Location 2	2.139	168
Location 3	1.405	224
Sample 3		
Location 1	1.321	140
Location 2	1.699	140
Location 3	0.545	196

Table – 5: Organic carbon and nitrogen in inorganic sample

Sample 1	Organic carbon %	Nitrogen (mg/kg)
Location 1	1.510	140
Location 2	1.384	364
Location 3	1.489	224
Sample 2		
Location 1	0.859	224
Location 2	1.678	504
Location 3	1.762	280

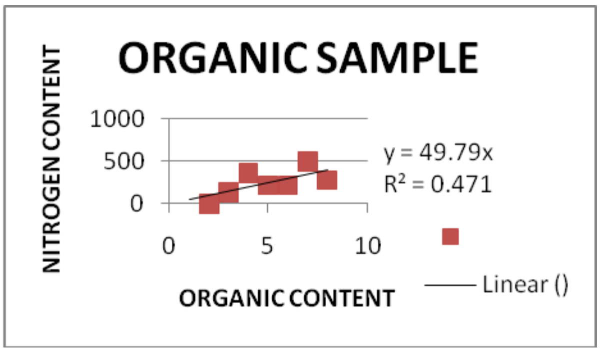

Chart -1: Comparison Of Organic And Nitrogen Content In Organic Sample.

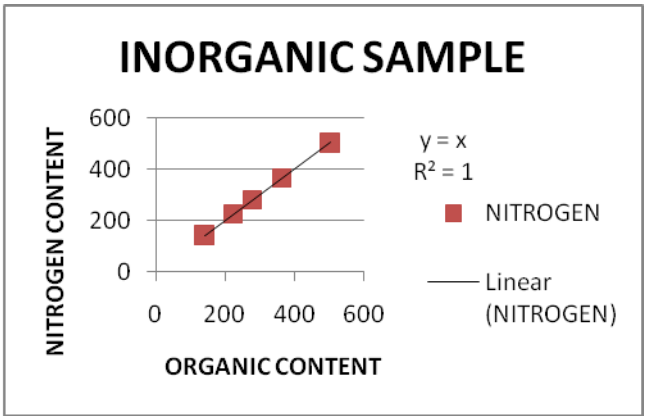

Chart -2: Comparison of Organic And Nitrogen Content In inorganic Sample.

4.2 pH of soil sample

The pH value of organic farm (OR) was found 6.8, similarly the value of conventional farm (IO) was 6.7. It was found that the pH value of organic farm was higher than the inorganic farm. This pH value indicates that both organic and conventional farm soil are slightly acidic in nature.

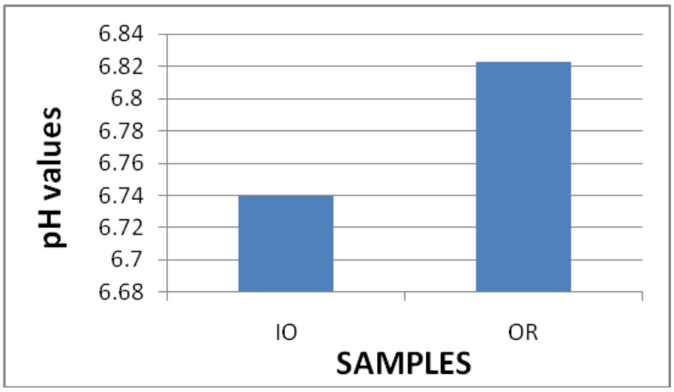

Chart -3: Soil Ph of organic and inorganic soil

4.3 Organic content of soil sample

The organic matter content of organic farm (OR) was found 1.6083, similarly the organic matter content of conventional farm (IO) was 1.433. The soil organic matter of organic farm soil was found higher than that of inorganic soil due to application of organic manures since last several years. Organic matter is directly proportional to nitrogen (N)-content. It is due to the release of nitrogen from organic matter. Organic matter influences physical properties of soil such as structure, water holding capacity and resistance to erosion. It may be due to absorptive property of colloidal organic matter which holds water tightly.

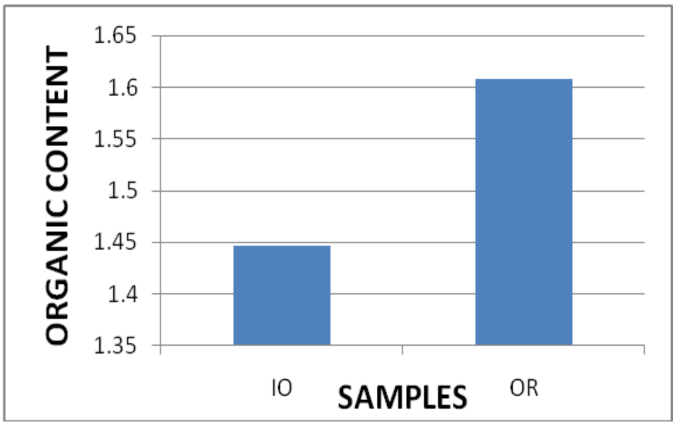

Chart -4: Organic content of organic and inorganic soil

4.4 Nitrogen content of soil sample

The total nitrogen content of organic soil (OR) was found 185, similarly, the nitrogen value of conventional soil (IO) was 289. From the calculation, it was found that nitrogen content in inorganic was higher than the organic sample. Usually the value of nitrogen in organic sample will be higher than inorganic soil since there was a climatic change during 4th week of collection of sample and moreover the work was carried out in a short period of time the nitrogen value was found to be decreased.

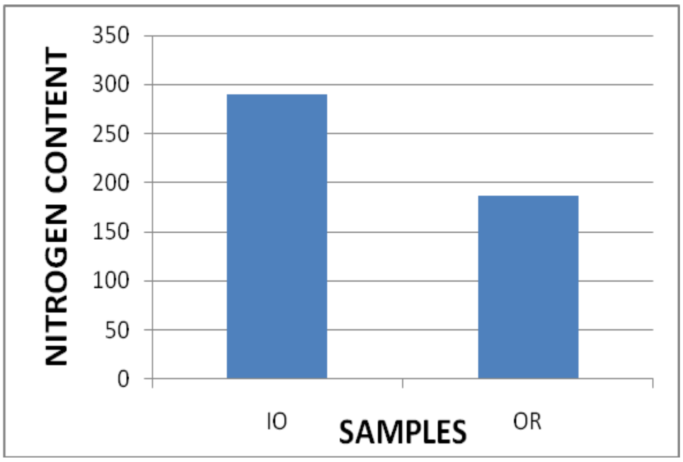

Chart -5: Nitrogen content in organic and inorganic soil

5. CONCLUSIONS

With regard to organic content in general, the soil organic carbon content was found to be relatively higher under organic farming system when compared to conventional farming system. However due to environmental factors like temperature and rainfall the organic content was found to decrease at the later of the experiment. Due to favorable microbial activities which might have favored high rate of decomposition of soil organic matter which results in loss of organic carbon. The nitrogen value will be usually higher for the organic soil since this work was done in a short period of time it is accounting to be less.

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