Organic Carbon and its Improvement in Soil

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INTRODUCTION

Soil organic matter content is used as an index of soil health, since it influences the soil in three ways, such as, physically, chemically, and biologically. The fibrous portion of organic matter plays an important role in improving soil physical properties. It promotes soil aggregation and improves permeability and aeration of clayey soils. Its high moisture-absorbing capacity and high carbon for growth of microbial mycelia may help in the granulation of sandy soils to improve the nutrient- and water-holding capacity. Organic matter accounts for at least half the cation exchange capacity (CEC) of soils. Thus, it is very important not only in retaining nutrients from fertilizers applied but also in increasing the buffering capacity of soils, besides enabling crops to better cope with such stresses like soil acidity and nutrient excess etc; It helps increase availability of many nutrient elements. By itself, organic matter is a source of nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and other secondary and micro nutrients. Within the organic matter, soil organic carbon forms a major component. Organic carbon constitutes about 58 per cent of the soil organic matter.

The decline in soil organic carbon in the recent times often associated with crop yield loss of about 30 per cent. Further, the depletion of soil organic carbon under intensive cropping system is the key factor in altering biological equilibrium of the soil ecosystem. It is essential to maintain soil organic carbon cycle, where all the soil organisms *viz.,* bacteria, fungi, actinomycetes, protozoa, earthworms etc., and they grow in the presence of sufficient amount of soil organic carbon.

Due to continuous cropping and ever-increasing use of fertilizers without adequate organic recycling has not only aggravated multi-nutrient deficiencies in soil and plant systems but also deteriorated soil productivity and created environmental pollution. Tamil Nadu is endowed with enormous potential for plant nutrients locked up in the biological wastes. These wastes can effectively be utilized for sustaining the soil health.

The amount of Organic Carbon in soils at the steady state can vary greatly. Organic Carbon level ranges from approximately 0.32 to 0.51 percent. The difference in Organic Carbon levels between soils are mainly due to variations in climate, soil characteristics, drainage condition, soil parent materials and human activities. The status of the Organic Carbon in Tamil Nadu is given in Table 1. The organic carbon in Tamil Nadu soil has gone down from 0.70 % in 1971 to 0.40 % in 2002, because of less use of organic inputs. The decline in organic carbon content has made undesirable changes in soil biodiversity and disruption in harmony of crop plants, which affects soil fertility and productivity. Considering its importance, the application of Farm Yard Manure, composting of farm wastes, green manures and biofertilizers plays a pivotal role in sustaining soil health.

Enhancement of Soil Organic Carbon

The soil gets organic matter added to them in various ways. The major sources are 1. The roots and stubbles of crops that are left behind after their harvest, 2. Leaves and other plant parts that are shed by the plants, 3. The organic manure like cattle manure and compost added to the soil and 4. The excreta and dead remains of the small soil animal like rodents, soil insects and the soil microorganisms. When fresh organic matter is added to the soil it is acted upon by various organisms; it loses its shape and structure, decomposes and gets merged with the soil as one of the soil ingredients, losing its identity. The organic matter that lost its structure and become part of the soil is called "humus".

The importance of soil organic carbon for soil fertility means that in agricultural and horticultural systems, soil organic carbon levels should be maintained at levels high enough to ensure its optimum effects on plant nutrition and soil physical conditions. In cropping systems, the amount of organic carbon in soil often declines and in time may reach a level at which soil structural problems may occur. In addition, nutritional problems such as lack of adequate nitrogen and sulphur may arise. In some areas, such problems have become more evident in recent years. It should be noted that the buildup of organic carbon in soils, by whatever means, is a slow process. However, the following strategies may help to improve the organic carbon content of the soil significantly.

1. **Crop rotation**: It improves soil organic carbon and soil biological activity besides preventing the leaching loss of nutrients. Not only organic carbon, but also nutrient addition is possible due to leaf litter and residues addition.

2. **Crop residues:** When field crops are harvested a significant proportion of their root system is left behind in the soil and becomes a source of organic carbon. Soil incorporation of straw and stubbles by in situ ploughing can be practiced wherever possible. Crop residues are the non-economic plant parts that are left in the field after harvest refuses that include straws, stubble, stover, and haulms of different crops. Crop remains are also from thrashing sheds or that are discarded during crop processing. This includes process wastes like groundnut shell, oil cakes, rice husks, and cobs of maize sorghum and Cumbu. The greatest potential as a biomass resource appears to be from the field residues of sorghum, maize, soybean, cotton, sugarcane etc. In Tamil Nadu 190 lakh tones of crop residues are available for use. These residues will contribute 1.0 lakh ton of nitrogen, 0.5 lakh ton of phosphorous and 2.0 lakh tons of potassium. How ever crop residues needs composting before being used as manure.

3. **Minimal cultivation and direct sowing**: Some agronomic practices like minimal tillage and direct sowing will help to reduce the rate of decomposition of soil native organic matter and sustain the level organic carbon.

4. **Green manuring:** It refers to growing of a green crop, usually a legume, which is not harvested but ploughed back directly into the soil thereby it adds organic carbon. In soils significant benefit may be obtained from such practice if carried out properly.

5. Addition of farm yard manure (including animal and poultry manure), bio manure, and biofertilizers will greatly improves the organic carbon in soil, besides improvement in the soil structure and texture. For example, an application of farm yard manure at a rate of 25 t ha^{-1} would increase the organic carbon content of the soil by 0.2 % before decomposition.

6. **Integrated Farming System**: Adoption of IFS components at field levels may help to improve the soil organic carbon mainly through recycling of various IFS components. It will also ensure effective utilization of crop residues and animal manures.

7. **Biocomposts and vermicomposts**: Bio compost is a new concept and can be prepared by using green leaves (nitrogenous materials) and dry leaves (carbonaceous materials) in 8-12 weeks. Addition of optimum levels of bio composts and vermicompost improves the organic carbon content in soil markedly. They promote the beneficial activity of microflora and fauna in the rhizosphere and thereby they provide the macro and micro elements and growth promoting substances (IAA, cytokinin and gibberellins) for better crop growth.

8. **Solid waste management**: Domestic, agriculture and industrial activities generate large amount of solid wastes which are rich in organic carbon. They should be properly decomposed with appropriate composting technologies before their land application. The composted solid wastes will enrich the soil organic carbon and nutrients.

Solid wastes are perceived as undesirable, useless and unwanted materials and substances that arise from human and animal activities. With increasing industrialization and population, solid waste generation has not only increased but its nature also changed. Municipal solid waste includes commercial and residential wastes generated in municipal or notified areas either in solid or semi-solid form excluding industrial hazardous waste but including treated bio-medical wastes.