

## Strategies to boost Soil Organic Carbon

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### SUMMARY

The most effective way to boost soil organic carbon is to focus on on-farm resources including crop leftovers, farmyard manure, compost, green manures, agroforestry biomass, and organic mulches, which provide continuous and low-cost carbon inputs to the soil. General cultivation practices like conservation tillage, cover cropping, soil biodiversity enhancement, moisture conservation and erosion control help stabilize and protect this carbon. When on-farm carbon inputs are insufficient, external inputs such as biochar, commercial compost, microbial cultures, and integrated nutrient management can supplement carbon build up. Together, these strategies enhance soil health, productivity and long-term carbon sequestration.

### INTRODUCTION

Soil organic carbon is a key indicator of soil fertility, crop productivity and ecosystem resilience. Declining soil organic carbon is a major concern in an intensive agricultural systems. Enhancing SOC requires a combination of farm-generated resources, natural ecological processes, and external inputs. This review categorizes SOC-building strategies based on their resource origin, beginning with on-farm and low-cost options before moving toward external inputs that depend on outside procurement.

#### On-Farm Resources for Building Soil Organic Carbon

##### Crop Residue Management:

Crop residues are the most abundant on-farm carbon resources. Retention, mulching, or incorporation of residues adds large quantities of biomass to soil. Residue recycling improves aggregate stability, enhances microbial activity, and prevents SOC loss through burning.

##### Farmyard Manure (FYM) and Animal Wastes

Farms with livestock generate FYM, poultry litter, and goatsheep manure. These materials are rich in organic carbon and nutrients, improve soil structure, and promote humus formation when applied regularly.

##### Composting of Farm Wastes

On-farm composting of crop residues, weeds, kitchen waste, and other organic by-products creates nutrient-rich compost. Vermicomposting further enhances microbial activity and improves carbon stabilization.

##### Green Manuring with Farm-Grown Legumes

Leguminous green manure crops such as sunhemp, cowpea, and dhaincha can be produced on-farm with minimal cost. Incorporation at flowering provides rapid biomass addition and improves both carbon and nitrogen status of soil.

##### Agroforestry and Farm Boundary Planting

Trees on farm boundaries, bunds, or integrated agroforestry systems contribute continuous biomass through leaf litter and root turnover. These perennial systems generate carbon-rich inputs without external purchases.

##### Organic Mulches from On-Farm Biomass

Mulching with dry leaves, grasses, pruned material, and farm wastes protects soil, reduces evaporation, and supports microbial activity—thereby increasing SOC under favorable microclimatic conditions.

##### Diversified & Legume-Based Cropping Systems

Intercropping, crop rotations, and inclusion of legumes (e.g., greengram, blackgram, cowpea) increase root biomass and biological nitrogen fixation. These are self-sustaining practices that continuously add organic matter.

#### Natural and Ecological Processes Supporting SOC Accumulation

##### Soil Biodiversity Enhancement

Encouraging natural soil fauna such as earthworms, termites, and beneficial microorganisms supports decomposition and humification. Avoiding excessive chemical pesticide use improves ecological balance and carbon stabilization.

##### Conservation Tillage and Natural Soil Protection

Reduced or zero tillage preserves soil aggregates, reduces oxidation of organic matter, and conserves natural carbon pools. Leaving soil undisturbed allows ecological buildup of carbon over time.

**Cover Cropping and Fallow Management**

Cover crops grown during off-seasons protect soil naturally from erosion, reduce runoff, and add biomass. Legume cover crops enhance nitrogen availability, further promoting SOC accumulation.

**Moisture Conservation Practices**

Practices such as contour bunding, mulching, and maintaining good soil infiltration support natural microbial processes that convert plant residues into stable carbon fractions.

**Soil Erosion Control Through Landscape Management**

Natural conservation methods—vegetative barriers, grassed waterways, terracing—protect carbon-rich topsoil. Preserving topsoil is essential for maintaining long-term SOC levels.

**External Resources and Inputs for Enhancing SOC****Commercial Organic Amendments**

When farm-derived organic matter is inadequate, externally sourced materials such as purchased compost, vermicompost, or enriched organic manures can improve SOC. These inputs are often microbial-enriched and enhance soil quality quickly.

**Biochar Application**

Biochar, produced industrially or purchased externally, is a highly stable carbon source. Application of biochar improves nutrient retention, water-holding capacity, and provides long-term carbon sequestration.

**Liquid Organic Formulations and Microbial Consortia**

Inputs such as Jeevamrutham, Panchagavya, waste decomposer cultures, PGPRs, and commercial microbial consortia purchased externally accelerate decomposition and formation of stable organic matter.

**Balanced Chemical Fertilizer Use in Integrated Systems**

External fertilizers, especially nitrogen, influence the dynamics of SOC. Integrated Nutrient Management (INM)—combining organic and inorganic fertilizers—supports SOC buildup by reducing imbalances and preventing excessive oxidation of organic matter.

**External Bio-Inputs and Biostimulants**

Humic acid, fulvic acid, seaweed extracts, and organic carbon-based formulations can enhance microbial activity and carbon turnover. These are supplementary inputs used when on-farm sources are insufficient.

**CONCLUSION**

Soil organic carbon can be enhanced effectively through a resource-based hierarchical approach. Priority should be given to on-farm, low-cost, self-sustaining resources such as crop residues, compost, green manure, agroforestry, and mulching. Natural ecological processes including soil biodiversity, conservation tillage, moisture conservation, and erosion control further strengthen carbon retention. External resources, including biochar, commercial organic inputs, liquid cultures, and integrated nutrient management, serve as valuable supplements where on-farm resources are limited. A combination of these strategies supports long-term soil health, productivity, and climate resilience through improved SOC sequestration.

**REFERENCES**

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