Rapid Composting Technique

Combating hunger through Soil Conservation

Ways to Enhance Soil Organic Carbon, Productivity and Soil Health Ways

India achieved a remarkable growth in agriculture as scientists from ICAR and Agricultural Universities have played a pioneering role in ushering Green Revolution by increasing food grains by 4 times, horticulture by 6 times, fisheries by 9 times, milk by 6 times and eggs by 27 times since 1950-51. Thereby, making a visible impact on the national food and nutritional security. But now we are witnessing the second generation problems due to intensive cultivation and imbalanced use of fertilizers and hardly any application of organic manure.

There is a sharp decline in soil organic carbon content, lowering of water table, climate change and lack of required genotype. A decline in yield and productivity of rice and wheat in Punjab, U.P, Bihar and other areas has shaken the planners and scientists. In fact, scientists have found out that less organic carbon in soil system is the main cause of decline in the response ratio of added chemical fertilizers, which follows the law of diminishing returns. The burgeoning population and scarcity of limited natural resources are heading our country to lesser and lesser food availability per capita and hence, there is an urgency to enhance food production and to make our country prosperous from food security point of view.

The decline in yield and fatigue in productivity have been indicated through long-term experiments in various cropping systems of different agroeco-regions of the country. Most of the Indian soils are deficient in nitrogen, phosphorus and zinc coupled with low organic matter is a constraint limiting the productivity of the soils. The amount of soil organic carbon in Indian soils is relatively low, less than 0.5%, influencing on soil fertility, microbial activity and physical condition. The data in Table 1 shows a decline in SOC concentration of cultivated soils by 30 to 60% compared with the antecedent level in undisturbed ecosystems. Organic carbon plays a multifunctional role in soil such as regulating nutrient supply to plant, buffering, filtering, restoring and maintaining soil health. Their efficient management is indispensable for the sustainability of production in different cropping systems. In view of ever escalating cost of chemical fertilizers the biodegradable organic sources is the only way to supplement the nutrients and save as the cost of fertilizers, sustain soil health and ecosystem functions.

Table 1: Depletion of soil organic carbon concentration of cultivated compared with that in undisturbed soils

Region	SOC content		Percent (%) reduction
	Cultivated (%)	Undisturbed (%)	
1. Northwest India			
● Indo-Gangetic Plains	0.42 ± 0.09	1.04 ± 0.36	59.6
● Northwest Himalaya	2.43 ± 0.87	3.45 ± 1.16	29.6
2. Northeast India	2.32 ± 1.04	3.83 ± 2.33	39.4
3. Southeast India	2.96 ± 3.01	4.37 ± 2.34	32.3
4. West coast	1.32 ± 0.81	1.86 ± 0.21	29.1
5. Deccan Plateau	0.77 ± 0.41	1.79 ±.0.76	57.0

Source: Swarup et al. (2000) modified from Jenny and Raychaudhary (1960)

Benefits of Stable Soil Organic

Physical Benefits

- Enhances aggregate stability and improves soil aeration
- Better seed germination
- Improves water infiltration by reducing runoff and thus increase water holding capacity
- Reduces the stickiness of clayey soils and thus making them easier to till
- Reduces surface crusting

Chemical Benefits

- Increases the cation exchange capacity (CEC) of soil or its ability to hold and supply essential nutrients such as calcium, magnesium and potassium
- Enhances fertilizer and water use efficiency
- Improves the buffering capacity i.e. ability of a soil to resist pH change
- Accelerates decomposition of soil minerals and making the nutrients available for plant uptake

Biological Benefits

- Provides food for the living organisms in the soil and efficiency of nitrogen fixing microbes is enhanced
- Enhances soil microbial biodiversity and activity which can help in the suppression of diseases and pests
- Enhances pore space through the actions of soil microorganisms and thus increases infiltration and reduced runoff

Availability of Biodegradable waste in India

Biodegradable organic wastes such as crop residues, agro industrial organic wastes, city garbage and forest litter have wide C/N ratios ranging from 80 to 110, and low concentration of available plant nutrients particularly N, P and K. On the basis of crop production levels, it is estimated that ten major crops (rice, wheat, sorghum, pearl millet, barley, finger millet, sugarcane, potato, tubers and pulses) of India generate about 679 Million tonnes (Mt) of crop residues, in which 226 Mt is actually available that has nutrient potential of about 5.6 Mt of NPK. The potential availability of all animal excreta is about 369 Mt of which 119 Mt is actually available that potentially supply about 1.7 Mt of plant nutrients. In recent survey, it is estimated that about 64.8 Mt of city wastes is generated every year from different cities of India that have nutrient potential of about 0.285 Mt of N, P and K. In addition to field crops, the estimated annual generation of byproducts/wastes from the horticultural and plantation sectors is estimated at 263.4 Mt, out of which, 134 Mt is considered to be available for recycling. It is also estimated that every million tonne increase in food grain production will produce 1.2-1.5 Mt of crop residue and every million increase in cattle population will provide additional 1.2 Mt of dry dung per annum. Every million increase in human population will discharge 16,500 tonne faeces (dry basis). Thus, the estimated NPK supply from all the wastes including crop residues is 5.0, 6.25 and 10.25 Mt, respectively during the year 1991, 2011 and 2030.

Organic solid wastes generated by agriculture, domestic, commercial and industrial activities are often indiscriminately disposed on the soils. However, under ordinary conditions of storage, there are significant losses of plant nutrients either by burning, uses as fuel cake, leaching or volatilization when manures remain exposed to sun and rain. It is estimated that if these wastes are managed properly in a scientific manner, it can be source of 10 Mt plant nutrients and would also improve soil health and crop productivity. **Thus, a sound technology is required to improve the quality of manures in the shortest possible time, where farmers can prepare the compost easily and improve its nutritional quality by the addition of cheap amendments such as rock phosphate and pyrites, micas etc.**

Composting and its Importance

Composting is a microbiological and non-polluting safe method for disposal and recycling of wastes by converting them into organic fertilizer. During composting, mixed microbial populations convert organic wastes into humus, which has significant value in agriculture. Anaerobic composting enhances denitrification processes and emits several green house gases to atmosphere.

The valid reasons for composting decomposable wastes of diverse origin and composition are:

- It improves the physical characteristics of agricultural wastes making them easy to handle and use.
- Composting lowers the C:N ratio of materials with wide C:N ratio such as cereal straw, thus avoiding nutrient competition between plants and microorganisms
- It reduces the final volume of waste by about half of its original volume
- It facilitates the recycling of humus and nutrients into the soil
- It protects and improves the microbiological diversity and quality of cultivated soils
- The high temperatures produced during composting sterilize weed seeds, kills pathogens and pests in the wastes, thus reducing the cost of production, health hazards and control pests and diseases
- It minimizes and even eliminates the problems arising from poor aeration such as emission of H_2S, phenolic compounds, methane etc.
- During composting, various microorganisms promote biodegradation of toxic compounds and pollutants (bioremediation)

Problems Using Immature Compost

- Less degree of stability and immaturity leads to the presence of phytotoxic material and also the pathogen growth Nitrogen immobilization at a high C:N ratio and thereby reduction in the supply of available N
- Stocking and bagging of wet and immature compost can induce anaerobic decomposition resulting in the production of toxic substances such as alcohol, methane and acetic acid
- Thus an appropriate decomposition technique must be adopted

Composting Technology for Solid Wastes from Rural and Urban Areas

Rural Areas:

In India 2/3rd part of cattle dung is used for fuels whereas only 1/3rd part is being used as farm yard manure for agriculture. Similarly the crop residue like wheat straw is being used for cattle feed or burnt directly in field. It is vital that we search for making best use of rural wastes as compost/organic manure and return back as much as to the soil. At the same time our endeavor should be that the composting technology should be easily adopted by the farmers and the quality should not be sacrificed. This would certainly keep the rural areas clean and would be savior from insect borne diseases.

Urban Areas:

In urban areas lots of garbage is produced. A rough estimate reveals that around 0.4 kg/day garbage is produced by one individual. It is estimated that in Delhi, Bombay, Chennai, Bangalore, Hyderabad and other metropolitan cities about 6000-9000 tonnes of garbage is produced daily (approximately). A concept of **Zero Garbage** can easily be adopted by Local Self Governments (LSG). Around 40% biodegradable segment can be easily separated for composting channel; rag and horticultural waste can be used for Residual Derived Fuel (RDF) purpose; metals, plastic and glassware may be readily sold back to industry for recycling. Thus, the LSG can make some money from this garbage, if the concept of zero garbage is properly and systematically adopted by them. Naturally there would not be any garbage mountains as normally encountered in the cities which pollutes the air, underground water, attract flies and a great nuisance for residents residing around the area.

Why Rapid Composting?

The normal time taken for compost preparation in most methods is rather long, ranging from 100-180 days. Considerable research has therefore been done to accelerate the composting process. This is possible by the introduction of suitable microorganisms with demonstrate efficiency in the rate of organic matter decomposition. The compost producers are presently using microbial inoculants for fast decomposition of biodegradable material and suppression of foul odor. We have isolated efficient cultures and these cultures are multiplied in the process.

Compost Microorganisms

In the process of composting, microorganisms break down organic matter and produce carbon dioxide, water, heat, and humus, the relatively stable organic end product. Under optimal conditions, composting proceeds through three phases: 1) the mesophilic, or moderate-temperature phase, which lasts for a couple of days, 2) the thermophilic, or high-temperature phase, which can last from a few days to several months, and finally, 3) cooling and maturation phase.

Microorganisms such as bacteria, fungi, and actinomycetes account for most of the decomposition that takes place in a pile. They are considered chemical decomposers, because they change the chemistry of organic wastes. Of all these organisms, **aerobic bacteria** are the most important decomposers. They are very abundant; there may be millions in a gram of soil or decaying organic matter. They are the most nutritionally diverse of all organisms and can eat nearly anything. Bacteria utilize carbon as a source of energy (to keep on eating) and nitrogen to build protein in their bodies (so they can grow and reproduce). They obtain energy by oxidizing organic material, especially the carbon fraction. This oxidation process heats up the compost pile from ambient air temperature.

Modern Rapid composting technologies have built-in systems, where controlled conditions create best environment for microbes to multiply growth and mitigate. Specific indigenous microbes are selected and cultivated which later reside inside the system, thereby requiring no refill or replacement once installed. This controlled environment results in efficient fermentation and drying to produce high quality and high value products

National Policy and Action Plan for Improving Compost Quality

In recent past, Inter-ministerial task force was set up by the Hon'ble Supreme Court of India, mainly for preparation of Policy Strategy and Action Plan for promoting integrated plant nutrient management (IPNM) using city compost along with synthetic fertilizers in every sector of agriculture, horticulture, plantation crops, forestry and rehabilitation of mining areas.

Further, the subgroup-1 of **Inter-ministerial task force** was appointed to study problems faced by compost plants, quality issues, marketability, sustainability, sale price and operation a n d maintenance issues. The sub group-2 of **Inter-ministerial task force** was further appointed to finalize the compost plant designs, drawings, specifications of plant machineries, land area requirement and operation and maintenance costs etc. The combined report of Task Force and Sub Group s (1 & 2) based on the availability of biodegradable component of the garbage and total class 1 city waste of about 50 million MT was submitted to the Urban Development Ministry for onward submission to the Hon'ble Supreme Court. The major thrust of the recommended policy are waste reduction through concerted Information, Education and Communication (IEC), segregation of different types of waste at source at home, in the hospitals and in the industry, resources recovery and recycling so that waste is turned into useful material for use in daily life and appropriate technology for safe collection, transportation and disposal of solid waste.

Quality Standards for City/Urban Compost

The Ministry of Agriculture, Govt. of India held series of meetings with the scientists, extension workers, composters, In-charges of quality control standards and others, and a gazette notification issued on Nov.3, 2009, which was later included in FCO (Table 2)

Table 2: Minimum quality standards for city/urban compost as per FCO (2013)

Parameters	City Compost
Moisture, per cent by weight, maximum	15.0 - 25.0
Colour	Dark brown to black
Odour	Absence of foul odor
Particle	Minimum 90% material should pass through 4.0 mm IS sieve
Bulk density (g/cc)	<1.0
Total organic carbon per cent by weight minimum	12.0
Total nitrogen (as N) per cent by weight, minimum	0.8
Total phosphates (as P2O5) per cent by weight, minimum	0.4
Total potash (as K2O) per cent by weight, minimum	0.4
C :N ratio	<20
pH (compost : water :: 1:2)	6.5 - 7.5
Conductivity (as dS m- 1) not more than	4.0
Pathogens	Nil
Heavy metal content (as mg/kg), maximum	Arsenic (as As2O3) 10.0, Cadmium (as Cd) 5.0
	Chromium (as Cr) 50.0, Copper (as Cu) 300.0,
	Mercury (as Hg) 0.15, Nickel (as Ni) 50.0,
	Lead (as Pb) 100.0, Zinc (as Zn) 1000.0