

Recycling of Organic Wastes for Sustainable Soil Health and Crop Growth

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Manuscript No: KN-V4-02/014

ABSTRACT

Recycling organic waste is vital for improving soil health and promoting sustainable agriculture. Practices such as composting, vermicomposting, and the use of organic fertilizers enhance soil fertility, structure, and microbial activity while mitigating environmental issues associated with waste disposal. Organic inputs, including farmyard manure, compost, and biochar, support crop growth, improve soil quality and help reduce greenhouse gas emissions. These waste-recycling approaches convert organic materials into nutrient-rich amendments that replenish soil nutrients, strengthen soil structure, promote microbial activity, and reduce reliance on synthetic fertilizers, thereby supporting environmentally and economically sustainable agricultural systems.

Key words: *organic waste, soil fertility, farmyard manure, composting, vermicomposting*

INTRODUCTION

A wide range of organic wastes generated from agricultural, animal, forest, and domestic activities-such as crop residues, weeds, forest biomass, animal by-products, and household wastes-serve as valuable recyclable resources rich in organic carbon and nutrients. Vermitechnology combines bio dung composting and vermicomposting using earthworms to convert organic wastes into nutrient-rich vermicomposting that supports soil health and crop growth. The incorporation of organic inputs, including crop residues, compost enriched with rock phosphate, biochar and liquid manures, significantly improves soil health and promotes sustainable agriculture. This study focuses on the recycling of agricultural organic wastes by addressing composting challenges, influencing factors, and techniques to enhance soil quality and crop productivity, emphasizing the need for sustainable soil management within a circular bioeconomy framework.

Need of recycling of organic wastes : The imperative for the recycling of organic waste is accentuated by various pivotal environmental and agricultural considerations. Organic waste, which represents a substantial fraction of the total waste produced on a global scale, presents significant challenges when relegated to landfills, particularly due to the generation of methane, a greenhouse gas that is roughly 20 times more effective in trapping heat than carbon dioxide. This phenomenon not only exacerbates climate change but also results in soil degradation and the creation of harmful leachate that poses risks to aquatic ecosystems and human health. In light of the increasing deficiency of essential plant nutrients in agricultural fields, the escalating costs associated with synthetic fertilizers, and the limited efficacy of chemical fertilizers, the recycling of organic waste for the provision of plant nutrients is becoming increasingly vital for the restoration of plant nutrients, the maintenance of soil health, the mitigation of pollution, and the generation of employment opportunities, which is progressively acknowledged as a viable strategy for sustainable agricultural production.

Advantages of recycling : The advantages of recycling organic wastes are numerous and impactful, contributing significantly to environmental sustainability, soil health, and economic efficiency. Here are the key benefits:

Three categories of organic waste : Organic waste encompasses crop residues such as straw, stover, husks, biomass from uncultivated plant species and weeds, forest biomass, animal waste and by-products including dung, urine, bones, fish processing residues, and human habitation waste comprising garbage, sewage, and sludge, among others.

Types of recycling of organic wastes

1.in-situ recycling: green manuring and bio mulches

2.ex-situ recycling: composting and vermicomposting

1.in-situ recycling: (green manuring)

Green manures consist of forage or leguminous crops cultivated specifically for their foliage, which is essential for soil conservation. The practice of applying green leaves and twigs derived from trees, shrubs, and herbs sourced from external locations is referred to as green leaf manuring. The cultivation of green manure crops or the application of green leaves enhances soil structure, increases the capacity for water retention, and mitigates soil erosion. Additionally, it curtails the proliferation of weeds and their growth. Furthermore, this practice aids in the reclamation of alkaline soils and reduces the incidence of root knot nematode infestations. Green manures serve as a valuable potential source of nitrogen and organic matter. In rice-based cropping systems, the species *Diancha (Sesbania sp.)* is particularly well-suited as a green manure crop for areas prone to waterlogging and heavy rainfall, while Sunhemp (*Crotalaria juncea*) is preferred for rainfed regions. Green gram, black gram, fodder cowpea, and horse gram are favoured green manure crops in tropical climates, whereas Niger and cockscomb are selected for their potash-rich characteristics as green manure crops.

Mulching: (bio mulches) : The application of mulch in the root zone suppresses weeds, improves water infiltration and soil moisture retention, maintains surface soil structure, enhances drought tolerance, and reduces erosion and nutrient leaching. Bio-mulches promote the decomposition of crop residues, nutrient cycling, and increase soil organic matter, while improving water and nutrient retention and stabilizing soil pH. They also supply macro- and micronutrients; however, their benefits may decline in hot and humid climates due to rapid decomposition. Bio-mulches should be applied at sowing in annual crops and during growth stages in perennial crops, with adequate soil moisture to ensure effective decomposition and nutrient release. Traditionally, organic mulches were widely used for weed control before the adoption of herbicides in vegetable production.

Ex situ recycling: composting : Composting is a natural, microbially driven process in which organic residues are decomposed under controlled conditions by bacteria, actinomycetes, and fungi. It improves soil physico-chemical and biological properties while supplying essential nutrients for plant growth. The process aims to sanitize and reduce waste volume, inactivate pathogens, parasites, and weed seeds, and produce a stable, uniform organic amendment. Composting converts complex organic compounds such as lignin, cellulose,

hemicellulose, polysaccharides, and proteins into readily available nutrients, resulting in the formation of humus and a stable organic end product.

Vermicomposting: Vermicomposting is an additional biological process that employs earthworms and microbial activity within controlled environmental conditions to convert organic waste materials into vermicompost, which serves as an exceptional, nutrient-dense organic fertilizer and soil conditioner (Yadav and Garg 2011).

Effect of recycled organic wastes on crop growth: The advantages derived from the application of compost or vermicompost are predominantly realized during the second and third years following application. When compost is utilized for fertilizing crops, the organic matter content of the soil progressively increases over time, allowing for a potential reduction in subsequent application rates due to enhanced nutrient cycling. Prolonged application of manure or compost can result in elevated levels of residual plant nutrients within the soil. The utilization of intrinsic nutrients from organic waste materials is paramount.

Benefits of recycling in nutrition management

Effect of organic wastes on soil properties : The utilization of organic wastes significantly improves soil physical properties such as structure, water retention, bulk density, porosity, aggregation, hydraulic conductivity, and resistance to erosion. Application of organic amendments, particularly vermicompost, enhances soil organic carbon, fulvic acid content, electrical conductivity and soil respiration while reducing bulk density. Increased soil organic carbon results from the continuous addition of carbon through crop residues and root biomass. Incorporation of crop residues also improves phosphorus availability, either through direct mineralization or indirectly via organic acids that promote phosphate desorption. Soil biological properties are highly responsive to management practices, and the addition of organic residues enhances biological activity and soil functioning, even under saline conditions.

Conclusion:

Furthermore, the repurposing of organic wastes aligns with the foundational tenets of a circular economy by transforming waste into invaluable resources, thereby mitigating pollution and fostering sustainable agricultural methodologies. The utilization of organic fertilizers, sourced from waste, not only bolsters agricultural productivity but also plays a pivotal role in advancing food security and environmental sustainability. Consequently, the proficient management of organic wastes through recycling is critical for the attainment of sustainable agricultural systems and the preservation of long-term soil health and crop productivity.

References:

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