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Sugarcane trash mulching: A sustainable carbon farming practice

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Sugarcane trash mulching is an effective carbon farming practice that improves soil health, enhances crop productivity, and reduces environmental impacts in Indian agriculture. The practice involves retaining sugarcane residues on the soil surface, which increases soil organic carbon, improves moisture conservation, and supports better nutrient cycling. The adoption of trash mulching across major sugarcane growing states such as Maharashtra, Karnataka, Tamil Nadu and Uttar Pradesh led to improvements in yield, water use efficiency, and soil quality under mulched conditions. By preventing residue burning, the practice also reduces greenhouse gas emissions and contributes to climate change mitigation. Sugarcane trash mulching supports key Sustainable Development Goals (SDGs), including efficient resource utilisation (SDG 12), climate action (SDG 13), and sustainable land management (SDG 15), making it a practical approach for climate-smart sugarcane cultivation in India.

Keywords: Carbon sequestration, Crop residue management, Soil moisture conservation, Sustainable land management, Water use efficiency

SUGARCANE cultivation plays a crucial role in India's agricultural economy, supporting millions of farmers and sustaining a large agro-based industry. However, the sustainability of sugarcane production is increasingly challenged by declining soil health, inefficient resource use, and environmental concerns associated with conventional farming practices. One of the major issues is the management of sugarcane residues, commonly referred to as trash, which are often burnt or removed from the field after harvest. This practice leads to the loss of valuable organic matter and nutrients, contributes to air pollution, and increases greenhouse gas emissions, thereby affecting both soil productivity and environmental quality. To address these challenges, sugarcane trash mulching has emerged as a practical and effective approach that aligns with the principles of climate-smart agriculture.

It is a carbon farming practice which retains crop residues on the soil surface, and helps in improving soil organic matter, conserving soil moisture, and enhancing nutrient cycling. It also reduces the need for external inputs such as irrigation and fertilisers, thereby lowering production costs. In addition, trash mulching contributes to carbon sequestration by increasing soil organic carbon levels and reducing emissions from residue burning. These combined benefits make it a promising strategy for promoting sustainable sugarcane cultivation under changing climatic conditions.

Trash mulching as a carbon farming practice

Carbon farming includes agricultural practices that capture and store atmospheric carbon dioxide in soils and vegetation. When farmers retain sugarcane residues on the soil surface instead of burning them, they increase soil organic carbon, improve soil fertility, and reduce emissions associated with residue burning. This practice transforms a commonly discarded by-product into a valuable resource that sustains soil productivity.

Trash mulching provides benefits beyond carbon sequestration. Organic matter enrichment improves soil aggregation, increases water-holding capacity, and enhances nutrient availability. These improvements become especially important under semi-arid tropical conditions, where many sugarcane-growing regions face water scarcity, declining soil fertility, and rising input costs. By improving soil physical and biological properties, trash mulching strengthens crop resilience to climatic variability, including drought and temperature stress, and helps stabilise yields.

Conventional vs trash mulching practice

In conventional system, the soil is left bare and

Residue retention practices during sugarcane harvesting at Surat district, Gujarat

unprotected when sugarcane residues are removed or burnt after harvest. Burning releases large amounts of carbon dioxide and other harmful gases into the atmosphere, contributing to air pollution and climate change. At the same time, valuable organic matter and soil carbon that could have enriched the soil are also gradually lost. The exposed soil becomes more prone to moisture loss, higher temperature fluctuations, and faster breakdown of existing organic matter, all of which reduce soil fertility over time.

In contrast, residue retention helps conserve soil moisture by reducing evaporation and keeps the soil temperature more stable. The retained trash slowly decomposes and adds organic carbon back into the soil, improving its structure and biological activity. Unlike burning, this method avoids direct greenhouse gas emissions and instead helps store carbon in the soil. The mulch layer also suppresses weed growth and reduces soil erosion, creating a more favourable environment for crop growth. Over time, residue retention builds healthier soils that are more resilient to drought and climatic stress. Though, burning or removing residues may offer short-term convenience, retaining them as mulch provides long-term benefits for both farmers and the environment.

Sugarcane trash mulching in India

Sugarcane cultivation in India generates a substantial quantity of crop residues, estimated at about 10–12 t/ha annually. Instead of treating this biomass as waste, trash mulching utilises it effectively by spreading it uniformly over the soil surface after harvest. This practice is gaining increasing attention in major sugarcane growing states such as Maharashtra, Uttar Pradesh, Karnataka, and Tamil Nadu, where it is being promoted as a component of sustainable crop management.

Adoption of sugarcane trash mulching in India shows clear regional variation. Tropical states such as Maharashtra, Karnataka, and Tamil Nadu exhibited relatively higher adoption due to better irrigation infrastructure, strong institutional support, and active extension services. Maharashtra, in particular, leads in adoption, especially in drip-irrigated sugarcane systems where trash mulching is promoted as a water conservation measure. In contrast, subtropical states like Uttar Pradesh and Bihar showed lower adoption levels despite having large areas under sugarcane cultivation. This is mainly due to limited awareness, smaller farm sizes, and constraints in residue management.

Benefits of sugarcane trash mulching

- One of the most immediate benefits of trash mulching is improved soil moisture conservation. The mulch layer acts as a protective cover, reducing evaporation losses and maintaining a more stable soil microclimate.
- When residues are retained on the soil surface, they decompose gradually, contributing organic matter to the soil. This process improves soil structure, enhances aggregation, soil carbon level and stimulates microbial activity, all of which are essential for maintaining soil fertility.
- It also improves water infiltration and reduces

Table 1. State-wise adoption status of sugarcane trash mulching in India

State	Adoption level (%)	Status of adoption	Reasons of adoption level
Maharashtra	40–60 (in irrigated belts)	High	Drip irrigation, strong sugar cooperatives, extension support
Karnataka	25–40	Moderate to High	Irrigated sugarcane systems, research support
Tamil Nadu	30–45	Moderate to High	Water-saving technologies, SSI (Sustainable Sugarcane Initiatives) practices
Uttar Pradesh	10–25	Moderate to Low	High area under cane but low mechanisation and awareness
Gujarat	20–35	Moderate	Progressive farmers, water scarcity driving adoption
Andhra Pradesh and Telangana	15–30	Moderate	Promotion under sustainable agriculture programmes
Punjab and Haryana	<10	Low	More focus on rice–wheat systems than sugarcane
Bihar	<10	Low	Smallholder dominance, low awareness

Source: Wakchaure *et al.* (2025)

runoff, ensuring that more water is retained within the root zone. Moreover, irrigation requirements can be reduced by 15–25% under mulched conditions, which is particularly important in water-scarce regions.

- The practice also contributes to improved soil physical properties. Mulched soils exhibit better porosity and reduced compaction, allowing for improved root growth and nutrient uptake. Over time, the increase in organic matter leads to enhanced soil buffering capacity and resilience to environmental stresses.
- By covering the soil surface, it reduces light penetration and suppresses weed germination. This results in lower weed pressure and reduces the need for herbicides and manual weeding. Farmers adopting this practice often observe a gradual decline in weed infestation over successive cropping cycles.

Table 2. Impact of sugarcane trash mulching on soil and crop performance

Parameter	Without mulching	With trash mulching
Soil organic carbon (%)	0.45–0.55	0.60–0.75
Cane yield (t/ha)	70–85	85–105
Irrigation requirement (%)	100	75–85
Trash utilisation (t/ha)	Nil	10–12 retained
Weed incidence	High	Reduced

Source: Shukla *et al.* (2022), ICAR-Sugarcane Breeding Institute (2024), Wakchaure *et al.* (2025)

Table 3. Contribution of sugarcane trash mulching towards Sustainable Development Goals (SDGs)

SDG	Contribution
SDG 1 (No Poverty)	Improves farm income through higher yields, reduced input costs, and better ratoon performance, thereby enhancing livelihood security of farmers.
SDG 3 (Good Health and Well-being)	Reduces air pollution by preventing residue burning, thereby improving environment and human health conditions in rural areas.
SDG 12 (Responsible Consumption and Production)	Promotes efficient utilisation of on-farm biomass by converting crop residues into a resource, reducing waste and improving nutrient recycling.
SDG 13 (Climate Action)	Reduces greenhouse gas emissions from residue burning and enhances soil carbon sequestration, contributing to climate change mitigation and adaptation.
SDG 15 (Life on Land)	Improves soil organic carbon, enhances biodiversity, and reduces land degradation, supporting sustainable land management.

- Sugarcane trash contains appreciable quantities of nutrients, particularly potassium. As the mulch decomposes, these nutrients are released slowly into the soil, improving nutrient availability and reducing dependence on external fertilisers. This contributes to improved nutrient use efficiency, nutrient recycling and reduces production costs.

Challenges in adoption

- One of the primary constraints is the traditional perception of crop residues as waste that must be removed or burnt for ease of field operations. Changing this perception requires sustained awareness and demonstration of long-term benefits.
- Operational challenges also exist in managing large quantities of trash in the field. Uniform spreading of residues and their proper decomposition require careful management, and in some cases, additional labour or machinery may be needed.
- Limited access to mechanised tools such as trash shredders can restrict adoption, particularly among small and marginal farmers.
- There are also concerns regarding pest and rodent incidence under mulched conditions, although these can be effectively managed through appropriate agronomic practices.
- Another limitation is the partial adoption of recommended practices, which reduces the overall effectiveness of mulching.
- Institutional support in the form of extension services, training programmes, and policy incentives is essential for scaling up this practice. Strengthening linkages between research institutions, sugar industries, and farmers can facilitate wider adoption and ensure proper implementation.

SUMMARY

Sugarcane trash mulching is a simple and effective carbon farming practice that enhances soil health, improves crop productivity, and reduces environmental impacts. By retaining crop residues in the field, farmers can increase soil organic carbon, conserve water, and reduce input costs. The practice contributes significantly to climate change mitigation and supports key SDGs related to food security, climate action, and sustainable land management. With appropriate awareness, technical support, and policy interventions, sugarcane trash mulching has strong potential to promote climate-smart agriculture and ensure the long-term sustainability of sugarcane-based farming systems in India.

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