

Khet Bachao Abhiyan Series: ICAR RCER, Patna

ICAR-Research Complex for Eastern Region, Patna

No-8: Crop Residue Management: An approach to Waste to Wealth

Crop residues are leftover wastes like stalks, straw and leaves left behind in field after harvesting crops like rice, wheat, maize etc. These crop residues are considered as "Nature's Gold" as these are available in plenty, source of multi-nutrients (macro-micro) and organic matter for soil enrichment. Unfortunately, this valuable treasure is completely ignored by the most farmers. Instead of effectively recycling it in agriculture, millions of tons of residues are burnt every year. Burning this "gold" causes nutrient loss, killing useful microbes in soil and emits greenhouse gasses like carbon di-oxide (CO₂) and nitrous-oxide (N₂O). By managing straw smartly instead of burning, farmers can lower their fertilizer costs and protect the soil health for posterity. Thus, efficient crop residue management is warranted to achieve goals of *Khet Bachao Abhiyaan* 2026 launched by ICAR-Ministry of Agriculture & Farmers Welfare (MA & FW)

In India, annual average generation of crop residue is about 500 million tonnes (mt). Generation of crop residues is the maximum in Uttar Pradesh (60 mt) followed by Punjab (51 mt) and Maharashtra (46 mt) (Table 1).

Table 1. Amount of residue produced by different crops in India

Crops	Annual residue generated (mt)	Share of total residue (%)
Rice	170	34
Wheat	110	22
Other Cereals (Maize, Millet)	72	14
Fibre Crops (Cotton, Jute)	66	13
Oilseeds & Pulses	42	8
Sugarcane (Tops & Leaves)	12	2

Advantages of crop residue management

- Crop residue contains essential nutrients, improve soil fertility and soil nutrient reserves
- Recycling of residues helps returning nutrients absorbed by crops back to soil
- Residue cover protects the soil surface from wind and water erosion
- Proper residue management reduces air pollution, GHGs emissions and nutrient losses
- Residue retention improves the soil health and conserve soil moisture,
- Residues can be used as animal feed, compost, bioenergy feedstock, industrial raw material, adding economic value and reducing fertilizer demand.
- Support long-term agricultural productivity and sustainability

Instead of its multifaceted values, farmers burnt crop residues as an easy way of rapid disposal after crop harvest, mostly for easy farm operations and timely sowing of next crops like wheat. This practice of burning has several negative effects on soil health, environmental

quality and agricultural sustainability. The heat generated during residue burning increases temperature of soil surface, often reaching levels that are harmful to the soil biota including bacteria, fungi, actinomycetes, algae and earthworms that play crucial roles in the soil organic matter decomposition, nutrient cycling, soil aggregation and maintenance of the soil fertility. Residue burning also causes loss of plant nutrients such as nitrogen, sulphur and carbon present in crop residue are volatilized and released into atmosphere during combustion. This not only reduces nutrient-supplying capacity of soil, also increases dependence on chemical fertilizers for subsequent crops. Furthermore, destruction of the soil organic matter adversely affects soil structure, water-holding capacity, aeration and overall soil health. Residue burning is a major source of GHGs such CO₂, CH₄, N₂O, CO and various volatile organic compounds are released into the atmosphere.

Table 2. Average Nutrient content and their losses from burning of crop residues

Crops	Nutrient content (%)			Nutrient loss (kg/ tonne residues)		
	N	P	K	N	P	K
Rice	0.61	0.18	1.38	6.1	1.8	13.8
Wheat	0.48	0.16	1.18	4.8	1.6	11.8
Maize	0.52	0.18	1.35	5.2	1.8	13.5
Pearl millet	0.45	0.16	1.14	4.5	1.6	11.4
Pulses	1.29	0.36	1.64	12.9	3.6	16.4
Oilseeds	0.80	0.21	0.93	8.0	2.1	9.3
Sugarcane	0.40	0.18	1.28	4.0	1.8	12.8

On Farm management of crop residues:

- ❖ **Residue retention:** It is a practice of keeping crop residues on soil surface after harvest to improve the soil health, conserve moisture, reduce erosion, enhance nutrient recycling and support sustainable crop production.
- ❖ **Residue incorporation:** Straw incorporation along with tillage operation is one of most common options for utilization of left-over residues in fields.

Off Farm management of crop residues

Vermicompost/Compost production: Residues can be converted into quality composts following composting/vermicomposting.

Biogas production: Residues can be converted into biogas, providing clean and renewable source of energy.

Mushroom production: Residues used as a substrate for mushroom production, transforming waste into nutritious food.

Animal fodder/bedding materials: Residues serve as a low-cost source of livestock feed and bedding materials which in-turn is recycled as farmyard manure.

Practical methods to manage crop residue

- Happy seeder technology: facilitates sowing of wheat after *khariif* rice directly under standing rice stubbles without any prior tillage. Standing straw acts as a natural mulch.
- Ploughing (Incorporation): Using machinery like rotavator/reverse mould board plough to chop/mix residue directly into the soil before watering, allowing it to decompose naturally.
- Spraying decomposer: Applying microbial solutions (eg. Pusa Decomposer) on stubble to accelerate the decomposition process, turning waste into rich manure within a month time.
- Mulching: Leaving residue on soil surface to conserve moisture, control weed growth and erosion and regulate soil temperature.
- Baling: Using a straw baler to compress loose residues into tight bundles, which can then be sold to farms (animal feed) or factories and generating extra income.
- Composting: Collecting residue and mixing it with cow dung and water in a compost pit to prepare high-quality organic manure for crop production.

Crop residues are a valuable resource for improving soil carbon reserve, sustaining soil health and farm productivity. Managing crop residue effectively through retention, incorporation, composting, mulching, bioenergy production and other value-added uses can transform this “Waste into Wealth”.

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