

Rice Straw to Resource: Crop Residue Management in Chhattisgarh

¹Neelam Sinha and ²Hem Prakash Verma

¹PhD Scholar, Department of Agricultural Economics, College of Agriculture, IGKV, Raipur (C.G.)

²Senior Research Fellow, ICAR-National Institute of Biotic Stress Management, Baronda, Raipur (C.G.)

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Abstract

Agriculture produces large volumes of crop residues including straw, stubble, stalks, husks and leaves particularly in cereal-based production systems. In regions dominated by rice-wheat cropping, inadequate residue management often leads to open-field burning, causing severe air pollution, greenhouse gas emissions, nutrient depletion, and soil degradation. Amid rising climate variability and increasing pressure on natural resources, sustainable crop residue management has become essential for climate-resilient and environmentally responsible agriculture. The concept, types and scientific management of crop residues through both in-situ and ex-situ approaches. In-situ practices such as mulching and soil incorporation improve soil organic carbon, moisture retention and nutrient cycling, while ex-situ uses including composting, bioenergy production, livestock applications and industrial processing convert residues into valuable economic resources. Despite clear environmental, agronomic and economic benefits, adoption remains constrained by high machinery costs, limited awareness, tight cropping schedules, and weak market linkages. The study emphasizes that an integrated, policy-driven approach combining technological innovation, farmer capacity building, financial support, and strong extension services is crucial to eliminate residue burning. Treating crop residues as productive assets rather than waste is key to enhancing soil health, boosting farm income, ensuring environmental sustainability, and securing long-term food security.

Introduction

Agriculture generates a large quantity of crop residues in the form of straw, stubble, stalks, husks, and leaves after harvesting. In cereal-dominated regions, particularly rice-growing areas, crop residue management has become a major environmental and agronomic concern (Lal, 2005). Farmers often resort to open-field burning of residues to clear fields quickly for the next crop. While this practice saves time and labour, it results in severe air pollution, loss of valuable soil nutrients, decline in soil organic matter, and emission of greenhouse gases (Pathak *et al.*, 2010).

With increasing climate variability, soil degradation, and pressure on natural resources, sustainable management of crop residues has become essential (FAO, 2017). Proper crop residue management not

only prevents environmental damage but also improves soil health, enhances productivity, and contributes to climate-resilient agriculture (Government of India, 2018).

Crop Residue Management

Crop residue management refers to the scientific handling, utilization, and disposal of crop residues in a manner that maintains soil fertility, improves resource-use efficiency, and minimizes negative environmental impacts (FAO, 2017). Residue management can be broadly classified into in-situ management, where residues are retained and managed within the field and ex-situ management, where residues are removed and used for other productive purposes (Government of India, 2018).

Types of Crop Residues

1. **Field Residues:** Residues left on the field after harvesting, such as paddy straw, wheat straw, maize stalks, and stubble.
2. **Processing Residues:** Residues generated during crop processing, such as rice husk, sugarcane bagasse, and oilseed cakes.

Both types of residues have significant potential for improving soil health, generating energy, and creating value-added products if managed properly.

Crop Residue Management Practices

1. In-situ Residue Management: In-situ management involves retaining residues in the field through mulching, surface retention, or incorporation into the soil. These practices improve soil organic carbon, enhance moisture retention, reduce erosion, and strengthen nutrient cycling (FAO, 2017). Conservation agriculture-based technologies such as the Happy Seeder have demonstrated significant potential for managing rice residues while enabling timely wheat sowing (Sidhu *et al.*, 2015).

2. Ex-situ Residue Management: In the ex-situ approach, residues are collected and utilized for composting, livestock feed, mushroom cultivation, bioenergy production, and industrial processing. Crop residues also serve as a valuable source of biomass for renewable energy and biofuel generation (Lal, 2005). Their utilization in bioenergy systems contributes to greenhouse gas mitigation and reduces dependence on fossil fuels (Pathak *et al.*, 2010).

Uses and Importance of Crop Residue Management

Crop residues have multiple productive uses in agriculture and allied sectors. They can be

converted into compost and organic manure, supporting sustainable soil nutrition, and are widely used in mushroom cultivation (Pathak *et al.*, 2010). Residues also serve as livestock bedding and treated fodder, while their role in bioenergy generation such as biogas, bio-CNG, briquettes, and biomass-based power is expanding rapidly. In addition, industries utilize crop residues for paper, pulp, and biodegradable packaging materials, creating value-added products from what was once considered waste. The importance of crop residue management extends across environmental, agronomic, and economic dimensions. Environmentally, it helps prevent air pollution caused by stubble burning, reduces greenhouse gas emissions, and conserves essential soil nutrients like nitrogen, phosphorus, and potassium. Agronomically, it improves soil fertility, enhances moisture retention, stabilizes yields, and supports conservation agriculture practices. Economically, it lowers farmers' dependence on chemical fertilizers and irrigation, promotes residue-based rural enterprises, and strengthens farm income and livelihood security. According to Food and Agriculture Organization, effective crop residue management is a key pillar of sustainable and climate-smart agricultural systems FAO (2017).

Challenges in Crop Residue Management

Despite its significant benefits, widespread adoption of crop residue management remains constrained by structural and practical challenges. Many small and marginal farmers lack access to affordable machinery and the high cost of equipment such as happy seeders and balers discourages investment (Government of India, 2018). Limited awareness about the long-term agronomic and economic gains further slows adoption, particularly in regions where traditional residue burning is deeply entrenched.

Additionally, the short turnaround time between harvesting one crop and sowing the next often compels farmers to opt for quicker residue disposal methods. Weak market linkages for residue-based products, such as biomass fuel or packaging material, also reduce economic incentives. Addressing these challenges through policy support, subsidies, awareness campaigns, and improved rural infrastructure will be essential to unlock the full potential of sustainable crop residue management (Government of India, 2018).

Way Forward: The future of crop residue management requires an integrated and policy-supported approach:

- Promoting in-situ residue management through conservation agriculture practices (FAO, 2017).
- Providing subsidies and custom hiring centres for residue management machinery.

- Encouraging residue-based value addition such as composting, bioenergy and mushroom cultivation.
- Strengthening extension services and farmer training.
- Supporting research and innovation in decomposers and low-cost technologies.
- Implementing incentive-based policies to discourage residue burning.

Conclusion

Crop residue management stands at the heart of sustainable and climate-resilient agriculture. When managed scientifically, crop residues enrich soil organic matter, improve nutrient cycling, conserve moisture, and significantly reduce environmental pollution caused by open-field burning. Rather than viewing residues as agricultural waste, recognizing them as valuable on-farm resources can transform farming systems into more efficient, regenerative, and environmentally responsible models of production. Shifting from residue burning to productive utilization, however, requires coordinated action among farmers, researchers, extension agencies, industries, and policymakers. Strengthening access to affordable machinery, promoting awareness of long-term agronomic and economic benefits, improving rural market linkages, and supporting residue-based enterprises are essential steps in this transition. With the right policy support and technological innovation, crop residues can contribute to bioenergy generation, organic nutrient management, livestock sustainability, and eco-friendly industrial production. Ultimately, effective crop residue management enhances farm productivity, reduces input costs, creates additional income opportunities and supports rural livelihoods. More importantly, it safeguards environmental sustainability and food security for future generations. As agriculture faces increasing climate and resource challenges, crop residue management is not merely an alternative practice it is a strategic imperative for building a resilient, profitable, and climate-smart agricultural future.

References

- Food and Agriculture Organization of the United Nations. (2017). Crop residue management in conservation agriculture. FAO. <https://www.fao.org>
- Government of India, Ministry of Agriculture & Farmers Welfare. (2018). National policy for management of crop residue. Government of India. <https://agricoop.nic.in>
- Lal, R. (2005). World crop residues production and implications of its use as a biofuel. *Environment International*, 31(4), 575-584. <https://doi.org/10.1016/j.envint.2004.09.005>

Pathak, H., Bhatia, A., Jain, N., & Aggarwal, P. K. (2010). Greenhouse gas emission and mitigation in Indian agriculture: A review, *IntechOpen*. <https://doi.org/10.5772/3953>

Sidhu, H. S., Singh, M., Singh, Y., Blackwell, J., Lohan, S. K., Humphreys, E., & Jat, M. L. (2015). Development and evaluation of the Happy Seeder for sowing wheat into rice residues in north-west India. *Field Crops Research*, 184, 201–212. <https://doi.org/10.1016/j.fcr.2015.09.019>.