Plant Archives Vol. 26, Supplement 1, 2026 pp. 1316-1324 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.174

PREVAILING AGRICULTURAL WASTE MANAGEMENT PRACTICES AMONG FARMERS IN EASTERN UTTAR PRADESH INDIA

Ishita Mishra* and V.L.V. Kameswari
Department of Agricultural Communication, G B Pant University of Agriculture and Technology, Pant Nagar, Udham Singh Nagar, Uttarakhand, India
*Corresponding author E-mail: ishitamishra199@gmail.com
(Date of Receiving : 25-10-2025; Date of Acceptance : 02-01-2026)

ABSTRACT

Agricultural waste management has become a significant concern in India. Increasing agricultural intensification and limited scientific disposal methods continue to generate large quantities of crop, horticultural, and animal waste. The present study examines the prevailing agricultural waste management practices among farmers in Eastern Uttar Pradesh, a region dominated by cereal-based cropping systems. Using a multistage random sampling technique, primary data was collected from 368 farmers across eight villages in Ayodhya and Varanasi districts. Both descriptive and analytical approaches were adopted, and qualitative responses were analysed using NVivo to identify behavioural patterns. Findings indicate that farmers largely depend on traditional, methods such as composting, in-situ incorporation, animal feeding, open dumping, and the use of dung cakes for fuel. The key factors guiding waste management practices include livestock feeding, maintaining soil and farm health, convenience, economic benefit, and, to a lesser extent, environmental sustainability. Although these practices support basic resource recycling, the utilisation of advanced waste-to-resource technologies remains limited due to infrastructural constraints, low awareness, and lack of extension support. The study concluded that agricultural waste in Eastern Uttar Pradesh functions both as a necessary resource and a potential environmental challenge. Strengthening farmer's awareness, promoting cost-effective technologies, and enhancing extension interventions are essential to transform agricultural waste into a productive asset for sustainable agriculture and rural development.
***Keywords*:** Sustainable, Agricultural Waste, Horticultural Waste, Animal Waste, Management.

Introduction

India is endowed with diverse agro-climatic zones that enable the cultivation of a wide range of field and horticultural crops, making agriculture a central pillar of the national economy. Since independence, policy emphasis has remained on achieving self-sufficiency in food grain production, particularly through the Green Revolution in the 1960s. Although these technological transformations significantly enhanced food security, they also resulted in large-scale intensification of agricultural production and the generation of substantial quantities of agricultural waste (Koopmans and Koppejan, 1997).

Agricultural waste today encompasses crop residues, livestock waste, horticultural by-products, processing residues, and packaging materials, a major part of which is still not managed scientifically. India produces over 500 million tonnes of crop residues annually (MNRE, 2009), with cereals accounting for nearly 70 per cent of the total crop residue waste produced (ICAR, 2011–12). Earlier studies have shown that rice and wheat residues constitute the largest share of crop waste, and a considerable proportion continues to be burnt in the open (Koopmans and Koppejan, 1997; Krishna *et al*., 2004), contributing heavily to air pollution, black carbon emissions and loss of soil nutrients. Burning is often adopted for operational convenience, especially in rice–wheat systems, despite clear evidence of nutrient losses and long-term soil degradation (Krishna *et al*., 2004; Ahmed *et al*., 2015).

Research further suggests that effective residue incorporation improves soil organic matter and enhances nutrient cycling, whereas burning results in major environmental and health costs (Wang *et al*., 2008; Bhattacharyya *et al*., 2021). Studies from other developing countries highlight the economic and environmental benefits of transforming residues into biogas, compost, or industrial products (Hiloidhari *et al*., 2014; Gabisa and Gheewala, 2018), indicating scope for technology-led opportunities in India. However, socio-economic constraints, limited awareness, and lack of infrastructure continue to restrict sustainable waste management practices across regions (Singh *et al*., 2021).

Although India holds tremendous potential to convert agricultural waste into energy, compost, biogas, briquettes, pellets, and other value-added products, lack of region-specific data and farmer-level behavioural understanding restricts effective utilization. Uttar Pradesh, being the largest agricultural state and a major residue producer, presents a particularly important case. While Western UP is dominated by sugarcane residues, Eastern Uttar Pradesh follows a cereal-intensive rice–wheat system generating rapidly decomposing residues that require timely and scientific management. Despite this, policy and research attention have largely focused on the north-western region due to stubble burning, leaving Eastern Uttar Pradesh comparatively underexplored.

In this context, understanding existing waste management practices and the reasons underlying farmers' choices becomes critical. Therefore, the present study entitled "Prevailing Agricultural Waste Management Practices Among Farmers in Eastern Uttar Pradesh" aims to examine prevailing practices and behavioural motivations shaping agricultural waste handling in this under-studied region. The findings intend to contribute to evidence-based insights for policymakers, extension agencies, and sustainability programmes to transform agricultural waste from an environmental burden into a productive resource supporting sustainable rural development.

Materials and Methods

The universe of the study comprised of farmers residing in the Eastern region of Uttar Pradesh. A multistage random sampling technique was employed to select the study area, ensuring adequate geographical coverage and representation. In the first stage, two districts Ayodhya and Varanasi were randomly selected from Eastern Uttar Pradesh. In the second stage, two blocks from each district were chosen through random sampling, namely Milkipur and Amaniganj from Ayodhya, and Badagaon and Harahua from Varanasi. In the next stage, two villages were randomly selected from each block, resulting in a total of eight sample villages. These were Ajrauli and Diligirdhar from Milkipur block, Bheekha Ka Purwa and Mohammadpur from Amaniganj block, Eshipur and Fattepur from Badagaon block, and Bhopapur and Gosaipur Mohaon from Harahua block. Together, these villages accounted for 4,480 households, which constituted the sampling frame for the study.

To determine the sample size Yamane's (1967) formula was applied at 95 per cent confidence level and a margin of 5.00 per cent error. Substituting the total number of households (N = 4,480) in the formula yielded a sample size of 368 households which was considered sufficiently representative of the population. In order to ensure proportional representation of households from each village and to minimize sampling bias, proportionate random sampling was employed.

Data was collected from 368 respondent households distributed across the eight selected villages. The proportional allocation resulted in the selection of 69 respondents from Ajrauli, 20 from Diligirdhar, 27 from Bheekha Ka Purwa, 90 from Mohammadpur, 16 from Eshipur, 9 from Fattepur, 45 from Bhopapur, and 92 from Gosaipur Mohaon. This allocation approach not only reflected the demographic characteristics of the sampling universe but also ensured adequate coverage of different farm sizes, socio-economic groups, and cropping conditions prevailing within each selected village.

With regard to research design, a combination of descriptive and analytical approaches was adopted. Descriptive design in the present study facilitated systematic documentation of existing agricultural waste management practices. By integrating both descriptive and analytical components, the study ensured comprehensive understanding of the phenomenon under investigation, thereby strengthening the reliability and analytical depth of the findings.

Results and Discussion

In many parts of India, particularly in regions like Eastern Uttar Pradesh where agriculture is the dominant livelihood source, farmers often rely on traditional and locally adapted methods for managing such waste. These practices are influenced by multiple factors such as landholding size, access to technology, level of awareness, labour availability, and socio-economic conditions. Assessing the prevailing waste management practices is, therefore, essential to

identify existing gaps between traditional approaches and scientific waste utilization methods. It helps in determining whether farmers view agricultural waste as a resource or as a burden requiring disposal. Moreover, understanding the existing behaviour provides a baseline for developing strategies to promote environmentally sound and economically viable waste management systems. In the context of this study, such an assessment is particularly relevant, as Eastern Uttar Pradesh represents a diverse agro-ecological region with variations in cropping patterns, farm sizes, and resource availability.

For the purpose of systematic analysis, agricultural waste in the study area was categorized into three broad groups i.e. Agricultural Waste, Horticultural Waste, and Animal Waste. This categorization helped in understanding the diversity of waste types generated through different farm operations and the corresponding management approaches adopted by the respondents. Within each category, farmers were asked to specify the common practices they follow for managing the waste. The major management methods identified across the study area included earth filling, composting, use as animal feed, fuel utilization, biogas production, mulching, open burning, and open dumping. These methods represent a mix of traditional, resource-recycling, and disposal-oriented practices that reflect the socio-economic and environmental realities of rural farming households.

Table 1 : Agricultural Waste Management Practices Prevailing in the Study Area

	Earth Filling	Composting	Animal Feed	Fuel	Biogas	Mulch	Open Burning	Open Dumping
Agricultural Waste	345 (93.75)	364 (98.91)	360 (97.82)	68 (18.47)	0 0	82 (22.28)	0 0	365 (99.18)
Horticultural Waste	322 (87.50)	360 (97.82)	47 (12.77)	0 0	0 0	0 0	0 0	366 (99.45)
Animal Waste	261 (70.92)	289 (78.53)	0 0	302 (82.06)	0 0	0 0	0 0	315 (85.59)

*Figures in brackets indicate percentage

Table 1.0 indicates that composting, open dumping, and animal feed utilization are the most common practices for managing agricultural waste in the study area. Earth filling is also widely adopted as a traditional method of incorporating crop stubbles into the soil. Although such practices support nutrient recycling, limited use for fuel, mulching, and complete absence for biogas generation reveal low technological adoption. In case of horticultural waste, composting and open dumping are the most dominant methods, with a smaller share used as goat feed. The limited diversification of horticultural waste handling suggests inadequate awareness and infrastructural constraints. Animal waste is primarily used as fuel in the form of dung cakes, followed by composting and open dumping, demonstrating the dual role of animal waste as both a household energy source and as for enhancing soil fertility resource. However, the absence of biogas plants points to unrealized renewable energy potential. Overall, the findings suggest that waste management in Eastern Uttar Pradesh is largely traditional and guided by convenience rather than scientific and sustainable approaches.

To understand the drivers behind these practices, qualitative analysis was done using NVivo to identify key behavioural themes. Agricultural waste management was influenced by convenience, economic benefits, soil and farm health, livestock feeding, and environmental considerations. Similar motivations were observed in horticultural and animal waste categories, indicating that farmers perceive waste more as a usable farm resource than a disposal problem. These insights highlight the importance of strengthening awareness, technological access, and extension support to promote integrated and sustainable waste management models in the region.

Reasons for Management of Agricultural Waste

Based on the qualitative analysis of farmers' responses, five major themes emerged as the key factors behind the management of agricultural waste in Eastern Uttar Pradesh. Arranged according to their frequency of occurrence, these themes are Livestock Feed (114 references), Soil and Farm Health (111 references), Convenience (70 references), Economic Benefits (46 references), and Environmental Sustainability (27 references). Each theme captures a distinct dimension of farmers' reasoning and reflects association between traditional knowledge, practical necessity, and the evolving understanding of sustainable waste utilization**.**

(A) Livestock Feed:

The most dominant reason for managing agricultural waste was its use as livestock feed, highlighting the interdependence between crop

cultivation and animal husbandry in Eastern Uttar Pradesh. Majority of farmers in this region maintain cattle, buffaloes, or goats as integral components of their farming system, ensuring a steady supply of milk, manure, and draught power. Agricultural residues such as paddy straw, wheat straw and maize stalks serve as valuable fodder, particularly during the lean seasons when green fodder is scarce. This practice represents an efficient and low-cost resource recycling mechanism, allowing farmers to meet livestock feed requirements without heavy dependence on purchased commercial feed.

Moreover, given the small and marginal landholdings prevalent in the region, the reuse of crop residues for animal feed reduces waste and simultaneously supports livelihood sustainability. Farmers often described this practice as "economically wise and naturally available" recognizing it as both a cost-saving strategy and a way to ensure food security through livestock productivity. In essence, this theme reflects the traditional ecological balance and circular use of resources that characterize rural farming systems in Eastern Uttar Pradesh.

(B) Soil and Farm Health:

Next to livestock feed, enhancement of soil and farm health emerged as another major motivation factor among farmers. Many respondents recognized that agricultural waste, when properly managed through composting, mulching, or manuring, plays a crucial role in improving soil fertility, structure, and organic matter content. These practices were often described as essential for maintaining the "living nature" of the soil and ensuring its long-term productivity and sustainability.

Farmers reported that the use of composted or decomposed organic waste helps in reducing dependence on chemical fertilizers, enhancing soil moisture retention, and promoting beneficial microbial activity, which ultimately results in healthier soil and better crop yield. Traditional farming wisdom, passed down through generations, supports the belief that "what comes from the soil should go back to the soil." This perception reflects a deep cultural and ecological understanding of soil as a living resource rather than merely a physical medium for crop cultivation.

In the study area, composting of agricultural waste is commonly practiced through soil turning of stubbles, wherein the remaining crop residues are ploughed back into the field. This process not only aids the natural decomposition of residues but also enriches the soil with organic nutrients, improves aeration, and enhances soil texture. Farmers believe that this method revitalizes soil health, supports microbial growth, and ensures sustainable productivity for future cropping cycles.

(C) Convenience

The third major theme, convenience, was associated with the practical and operational ease of waste management practices. Farmers in Eastern Uttar Pradesh, especially smallholders with limited labor and equipment, prefer methods that are simple, less time-consuming, and require minimal external inputs. Practices like in-situ incorporation of crop residues, open dumping, or sometimes controlled burning are often chosen due to their immediate feasibility, particularly during periods of labor scarcity or when farmers are practicing sequential cropping cycles.

The absence of mechanized residue management tools such as shredders or balers, coupled with the lack of organized collection and recycling systems, further contributes to the preference for convenient disposal methods. Farmers often justify their choice by emphasizing the need to "clear the field quickly" to prepare for the next sowing. Therefore, convenience-oriented decisions are less about neglect and more about managing time, labor, and resources efficiently in a challenging agricultural environment.

(D) Economic Benefits

Economic motivation was another critical factor influencing the adoption of certain waste management practices. For small and marginal farmers in, cost-saving and income-generating opportunities serve as strong incentives for utilizing agricultural waste effectively. Many farmers highlighted that using crop residues for mulching, composting, or animal feed helps in reducing expenditure on fertilizers, soil amendments, and purchase of fodder, thereby improving overall farm profitability.

In some areas, particularly where market linkages exist, farmers also sell surplus residues such as paddy straw, sugarcane trash, or maize cobs to traders and industries engaged in biofuel production, mushroom cultivation, or livestock feed processing. This not only ensures additional income but also prevents waste accumulation on the farm. In certain villages, farmers mentioned that excess feed and fodder residues are often sold or shared with neighbouring farmers, creating a small-scale local exchange system that supports community-level resource utilization.

Thus, agricultural waste is sometimes viewed as an economic resource rather than a liability. This economic dimension not only promotes livelihood diversification but also enhances farmers' willingness to adopt sustainable waste management practices

particularly when such practices are perceived as financially beneficial and locally viable.

(E) Environmental Sustainability

Although stated less frequently, the theme of environmental sustainability reflects an increasing understanding among farmers of the ecological implications of waste disposal practices. A section of respondents particularly those exposed to higher education and extension contact recognized that unsustainable management of agricultural waste leads to pollution, nutrient loss, and long-term soil degradation. Consequently, they supported eco-friendly alternatives.

This understanding, though developing gradually, signifies a positive shift in farmers' approach toward sustainable agriculture and responsible environmental stewardship. Some farmers expressed moral and community-based concerns, emphasizing their "duty to protect the environment for future generations". Such sentiments, though not yet widespread, indicate the potential for policy measures and incentives to encourage the adoption of environmentally sound agricultural waste management practices.

Reasons for Horticultural Waste Management

Based on the qualitative analysis of farmers' responses, five major themes emerged as the key motivators behind the management of horticultural waste in Eastern Uttar Pradesh. Arranged according to the number of references, these themes are Soil and Farm Health (116 references), Convenience (93 references), Livestock Feed (83 references), Economic Benefit (55 references), and Environmental Sustainability (23 references). Each theme highlights the practical, economic, and ecological considerations shaping farmers' decisions, reflecting the region's unique farming systems and resource constraints.

(A) Soil and Farm Health

The most frequently stated reason for managing horticultural waste was its contribution to soil and farm health. Farmers reported that horticultural residues such as leaves, stems, fruit peels, and pruning waste when incorporated into the soil through composting, mulching, or manuring, significantly improve soil fertility, organic matter content, structure, and moisture retention. These practices help maintain a balanced nutrient profile and support microbial activity, which are crucial for the long-term productivity of vegetable and fruit crops. In Eastern Uttar Pradesh, where most farmers operate on small and marginal holdings, such practices are considered a cost-effective and sustainable strategy to maintain soil vitality and enhance crop yields without excessive reliance on chemical fertilizers. Additionally, farmers emphasized that incorporating horticultural waste into the soil reflects their traditional understanding that soil health must be continuously replenished to maintain long-term productivity.

(B) Convenience

Convenience emerged as another significant factor influencing horticultural waste management practices. Farmers often prefer methods that are easy to implement, require minimal labour, and can be carried out quickly, particularly during busy cropping seasons. Practices such as *in-situ* decomposition, or temporary stacking of residues are widely adopted because they demand minimal additional effort while allowing the field to remain manageable for subsequent cultivation. Limited access to mechanized tools or organized waste collection systems for horticultural crops further encourages farmers to adopt practical, low-input strategies that fit within the constraints of small-scale farming operations. In many cases, the choice of convenient methods ensures that the horticultural crop residues do not interfere with timely planting of the next crop, which is crucial for maintaining crop cycles and productivity.

(C) Livestock Feed

A substantial portion of horticultural waste is directed toward livestock feed, especially for goats and other small ruminants, which are commonly reared in Eastern Uttar Pradesh. Leaves, stalks, and fruit residues serve as nutritious and readily available fodder, reducing reliance on purchased feed and reducing household expenditure. Farmers reported that they prioritize feeding livestock with these residues before other uses, demonstrating the integrated nature of crop-livestock farming systems in the region. This practice not only ensures that waste is efficiently utilized but also supports animal health, milk production, and income generation from livestock products. The use of horticultural residues as feed exemplifies the circular use of farm resources, reflecting both practicality and traditional ecological knowledge.

(D) Economic Benefit

Economic motivation is another important driver behind horticultural waste management. Farmers frequently convert residues into compost or organic manure, which helps reduce expenditure on fertilizers and soil amendments. In some areas, surplus compost or well-decomposed residues are sold locally, providing an additional source of income for smallholders. This economic dimension encourages

farmers to view horticultural waste not as a liability but as a valuable farm resource that can be reused or monetized. By integrating waste management into the farm economy, farmers are able to diversify their income sources, enhance farm efficiency, and adopt practices that are both profitable and environmentally beneficial.

(E) Environmental Sustainability

As in case of agricultural waste management, environmental sustainability was less frequently stated for horticultural waste also. Environmental considerations reflect farmers' recognition of the ecological impacts of horticultural waste disposal. The farmers in the area emphasized the critical need to avoid residue burning in order to reduce pollution and protect both soil and ecosystem health. Although such views are not yet universally adopted, they reflect a growing shift among farmers toward environmentally responsible practices, largely influenced by the visible benefits of composting, mulching, and incorporation of waste into the soil. Farmers who engage in these practices increasingly view them as a conscientious and sustainable way to manage farm resources, ensuring that waste is transformed into a productive input rather than a liability. This emerging orientation toward eco-friendly waste handling signifies not only greater environmental awareness but also a broader recognition that responsible waste management enhances farm productivity while safeguarding the surrounding environment.

Reasons for Animal Waste Management

Based on the qualitative analysis of farmers' responses, five major themes emerged as the key motivators behind the management of animal waste in Eastern Uttar Pradesh. Arranged according to the number of references, these themes are Fuel and Renewable Energy (108 references), Soil and Farm Health Enhancement (89 references), Convenience (52 references), Economic Benefit (47 references), and Environmental Sustainability (26 references). These themes highlight the multi-dimensional considerations that influence farmers' management practices for animal waste in the region.

(A) Fuel and Renewable Energy

The most frequently way of managing animal waste was its use as fuel for cooking**,** particularly in the form of dung cakes**.** Farmers in Eastern Uttar Pradesh often collect cow, buffalo, and goat dung to produce fuel for cooking and lighting, which serves as a reliable, low-cost, energy source for rural households. This practice not only reduces dependency on firewood and fossil fuels but also addresses issues of energy scarcity in the villages. The use of dung cakes as fuel is particularly valued because it transforms what would otherwise be a disposal challenge into a practical and useful energy source, contributing to household cooking needs while also reducing reliance on firewood.

(B) Soil and Farm Health Enhancement:

Another key motivation for managing animal waste is its role in enhancing soil fertility and farm productivity. Dung and other animal residues are widely used as organic manure or compost, which improves soil structure, nutrient content, and moisture retention, leading to better crop growth. Farmers in Eastern Uttar Pradesh, particularly those practicing mixed farming systems, view the recycling of animal waste as a natural and cost-effective method of maintain long-term soil health. This practice reflects traditional knowledge that sees animal waste as an essential resource for sustaining farm productivity, while also reducing reliance on chemical fertilizers.

(C) Convenience

Convenience also plays a significant role in determining the management of animal waste. Farmers prefer methods that are easy to implement and require minimal labour, especially when handling large quantities of dung and livestock residues. Practices such as collecting dung for preparing dung cakes or composting in pits near the household or farm are chosen for their practicality, enabling farmers to manage waste efficiently while minimizing the effort and time involved. The accessibility of simple, manageable practices ensures that animal waste is effectively utilized, which is particularly important for small and marginal farmers with limited resources.

(D) Economic Benefit

In addition to direct financial benefits, farmers also emphasized several secondary economic advantages derived from alternative uses of animal waste. In many villages, dung is mixed with mud and used as a low-cost plastering material for walls and floors, reducing construction and maintenance expenses while providing natural insulation Furthermore, animal waste is an important component in preparing organic formulations such as *jeevamrit* and biological pest repellents, which help farmers reduce their reliance on market-purchased inputs. Collectively, these diversified uses demonstrate that animal waste functions as a versatile resource that supports cost savings, enhances farm-level sustainability, and strengthens overall household economic resilience.

(E) Environmental Sustainability

Proper management of animal waste helps reduce open dumping and uncontrolled decomposition, which can lead to odor, water contamination, and greenhouse gas emissions. Farmers who adopt structured composting practices recognize the positive environmental impact, including cleaner surroundings and reduced pollution. While this motivation is not yet widespread, it demonstrates a developing appreciation for eco-friendly and responsible waste management practices within rural farming communities.

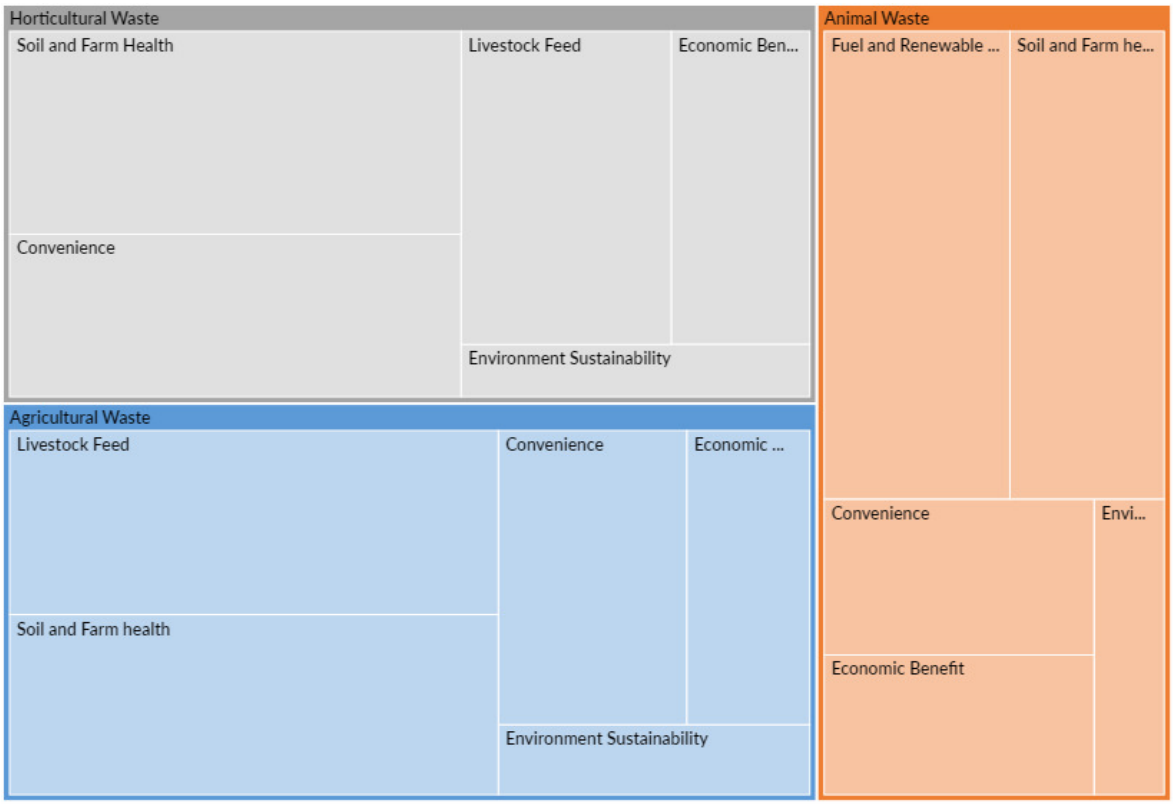

Fig. 1: Major Waste Management Themes in the Study Area.

The tree map visualizes the relative importance of different reasons farmers manage agricultural, horticultural, and animal waste**,** with the size of each block representing the frequency or significance of that reason.

1. **Agricultural Waste**
   - Livestock Feed and Soil and Farm Health are the largest blocks, indicating these are the primary motivations for farmers to manage agricultural waste.
   - Convenience**,** Economic Benefit**,** and Environmental Sustainability are smaller but still notable factors.
2. **Horticultural Waste**
   - Soil and Farm Health and Livestock Feed dominate, indicating that farmers primarily manage horticultural waste for improving soil fertility and feeding animals.
   - Convenience**,** Economic Benefit**,** and Environmental Sustainability are less prominent reasons.
3. **Animal Waste**
   - Fuel and Renewable Energy is the largest block, highlighting that a major use of animal waste is for energy purposes.
   - Soil and Farm Health**,** Economic Benefit**,** and Convenience are also reasons, though smaller in comparison.
   - Environmental Sustainability appears but is the least stated factor.

Across all types of agricultural waste, the management practices of farmers consistently highlight the importance of soil and farm health as well as livestock feed, indicting the important role of waste in maintaining overall farm productivity. Animal waste stands out due to its significant contribution to fuel and

renewable energy, a feature not observed with crop waste. While environmental sustainability is acknowledged as a reason for waste management, it emerges as a less prominent motivator, indicating that farmers tend to prioritize immediate practical and economic benefits over long-term ecological considerations.

Conclusion

The findings of the present study clearly demonstrate that agricultural waste management practices among farmers in Eastern Uttar Pradesh are predominantly shaped by traditional knowledge, practical considerations, and resource availability rather than by scientifically advanced or technology-driven approaches. Across agricultural, horticultural, and animal waste categories, farmers continue to rely on practices that align with local needs, labour availability, and immediate utility. Although such practices support a certain level of waste recycling and resource utilization, they also reflect a larger dependence on informal, unstructured methods that may not always contribute to long-term sustainability. Overall, the results reveal that farmers perceive agricultural waste primarily as a useful input within the farm system rather than as a pollutant or an environmental burden. The most dominant reasons for agricultural waste management were linked to livestock feeding, soil fertility enhancement, convenience, and economic benefit, indicating the strong interdependence between crop cultivation and animal husbandry in the region. The recycling of crop residues for animal feed and the incorporation of stubbles into soil illustrate a practical ecological cycle embedded within farming operations. However, composting and in-situ incorporation were frequently practiced, the absence of advanced measures such as biogas production or mechanized residue management points to technological gaps and inadequate infrastructural support.

Horticultural waste was largely managed through composting, open dumping, and in some cases, feeding to goats. The fact that horticultural residues are perceived as supplementary livestock feed highlights the multifunctional nature of waste within small farm households. Yet, the lack of diversified utilization such as mulching, energy recovery, or processing reflects limited awareness of farmers and insufficient exposure to improved technologies. Similarly, animal waste management was driven mainly by fuel needs, manure preparation, and convenience. The prominent use of dung cakes as cooking fuel underlines persistent rural energy challenges and the continued relevance of low-cost, renewable household energy sources. A significant finding emerging from the thematic analysis is that although environmental sustainability was acknowledged by a section of farmers, it was comparatively less emphasized than economic or practical motivations. Nevertheless, such responses indicate the early development of an environmental consciousness that can be strengthened through extension interventions and awareness initiatives. The findings, therefore, highlight the need for context-specific extension strategies that build upon farmers' existing knowledge while gradually introducing improved technologies and scientific waste management practices.

The study shows that agricultural waste management in Eastern Uttar Pradesh must be addressed not merely through technological solutions but through integrated farmer-centric approaches that consider behavioural, economic, infrastructural, and socio-cultural dimensions. Given the region's cereal-dominated cropping pattern and large volume of rapidly decomposing residues, targeted interventions such as decentralized composting, biogas units, residue management machinery, and training programmes can play a crucial role. Strengthening access to information, promoting awareness of environmental impacts, and improving institutional linkages between farmers, extension agencies, and local markets can further support sustainable waste utilization. In conclusion, agricultural waste in Eastern Uttar Pradesh represents both a challenge and a potential resource. While prevailing practices reflect traditional ecological knowledge and provide essential household benefits, they also highlight critical gaps that limit the full realization of waste-to-resource opportunities. By addressing behavioural determinants, infrastructural limitations, and awareness deficits, agricultural waste management can significantly contribute to environmental sustainability, rural livelihoods, soil health, and regional economic development. Strengthening scientific waste management through region-specific extension models will not only reduce environmental burdens but also transform agricultural waste into a productive asset supporting a more sustainable agricultural future in Eastern Uttar Pradesh.

References

Ahmed, T., Ahmad, B., & Ahmad, W. (2015). Why do farmers burn rice residue? Examining farmers' choices in Punjab, Pakistan. *Land Use Policy*, **47**, 448–458. https://doi.org/10.1016/j.landusepol.2015.05.001

Gabisa, E. W., & Gheewala, S. H. (2018). Potential of bio-energy production in Ethiopia based on available biomass residues. *Biomass and Bioenergy*, **111**, 77–87.

Hiloidhari, M. *et al.* (2014). Crop residue biomass database of India. *Biofuels, Bioproducts and Biorefining*.

Koopmans, A., & Koppejan, J. (1997). *Agricultural and forest residues—Generation, utilization and availability*. In Proceedings of the Regional Consultation on Modern Application of Biomass Energy (pp. 57–62). Kuala Lumpur, Malaysia.

Krishna, G. M., Arun, K. M., Kuntal, M. H., Kali, K. B., Prabir, K.G., & Manoranjan, M. (2004). Rice residue-management options and effects on soil properties and crop productivity. *Food, Agriculture & Environment*, **2**(1), 224–231.

Singh, R., Panwar, N. L., & Yadav, V. (2021). Biomass briquettes: A sustainable source of renewable energy for meeting the present and future energy needs. *Materials Today: Proceedings*, **47**, 1415–1421.