AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 03, Issue: 03 (March, 2026)
Available online at http://www.agrimagazine.in

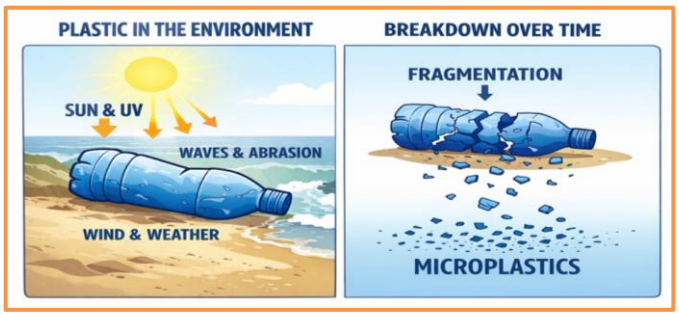
Microplastics Contaminate Organic Waste: Emerging Environmental Concerns and Challenges in Plastic Recycling

*K. Navya[1], Dr. Rajeshwar Naik[2], Dr. M. Shankaraiah[3] and Dr. S. Triveni[4]
[1]Ph.D. Scholar, Department of Soil Science and Agriculture Chemistry, College of Agriculture, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana, India
[2]Professor, Department of Soil Science and Agriculture Chemistry, College of Agriculture, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana, India
[3]Principal Scientist, AICRP on MSPE, Soil Health Unit, ARI, Department of Soil Science and Agriculture Chemistry, College of Agriculture, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana, India
[4]Professor, University Head, Department of AMBE, College of Agriculture, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana, India
*Corresponding Author's email: navya30kothakapu@gmail.com

Microplastics (MPs), defined as plastic particles smaller than 5 mm, have emerged as a pervasive environmental pollutant. Recent studies reveal that organic waste streams such as compost, biosolids, and food waste are increasingly contaminated with microplastics, raising serious environmental and sustainability concerns. These contaminants originate from improper waste segregation, plastic packaging, and even biodegradable materials that fail to fully degrade under composting conditions. The presence of MPs in organic waste not only compromises compost quality but also contributes to soil pollution and ecological risks. Furthermore, microplastic contamination complicates recycling processes by reducing material quality and efficiency. This article reviews the sources, pathways, impacts, and challenges associated with microplastic contamination in organic waste.

Introduction

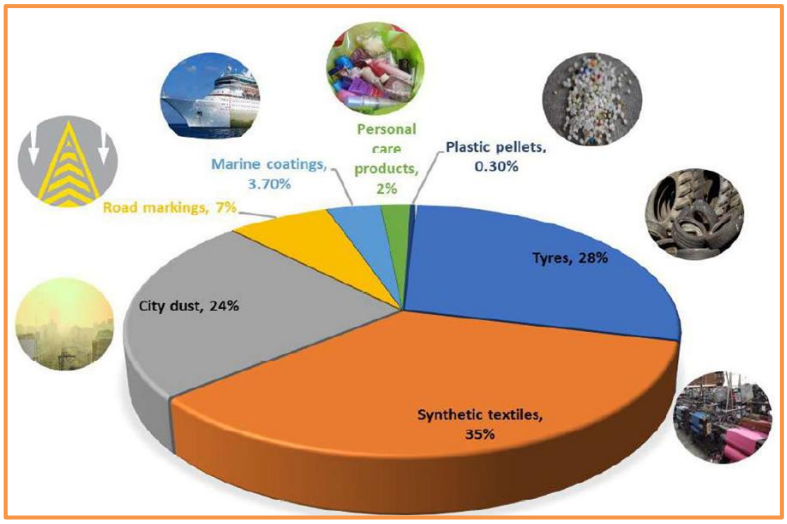
Plastic production has increased exponentially over the past decades, resulting in widespread environmental contamination (Geyer *et al.*, 2017). Microplastics, formed through fragmentation or directly released particles, are now found across terrestrial and aquatic environments (Zhang *et al.*, 2023). Organic waste management systems, especially composting, are widely considered sustainable solutions for recycling biodegradable materials (Ruffell *et al.*, 2025). However, recent studies indicate that these systems are increasingly becoming pathways for microplastic pollution due to contamination from mixed waste streams and packaging materials (MDPI, 2023). The accumulation of microplastics in organic waste systems threatens soil quality and ecosystem health, highlighting the need for improved waste management practices (Bayo *et al.*, 2025).



Sources of Microplastics in Organic Waste

Microplastics enter organic waste systems through multiple pathways:

- **Improper waste segregation:** Mixing of plastic and organic waste is a major contributor (MDPI, 2023).
- **Packaging materials:** Food packaging plastics are a dominant source (Geyer *et al.*, 2017).
- **Biodegradable plastics:** Materials such as PLA and PBAT often fragment rather than fully degrade (Ruffell *et al.*, 2025).
- **Wastewater biosolids:** Sewage sludge used in compost contains significant microplastic loads .



Sources of microplastics

Studies show that microplastics are present in most compost types regardless of feedstock, indicating widespread contamination (Zhang *et al.*, 2023)

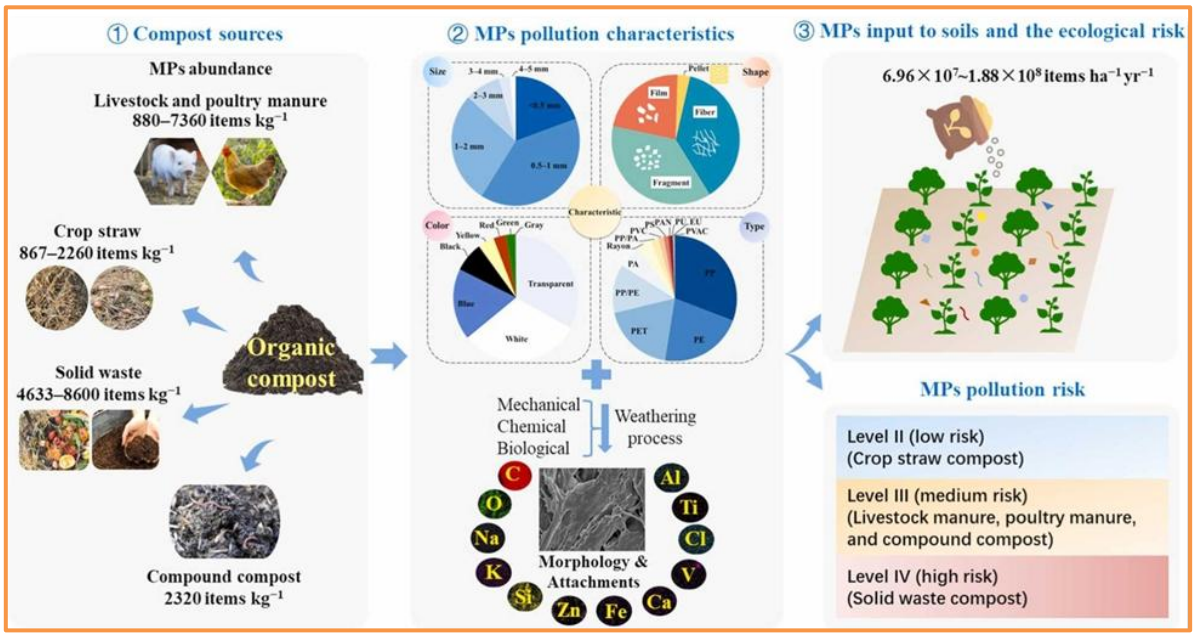
Microplastics in Compost and Soil Systems

Organic compost has been identified as a key pathway for transferring microplastics into soils (Zhang *et al.*, 2023). Once applied, these particles persist and accumulate over time.

Research findings indicate that:

- Compost frequently contains measurable concentrations of microplastics (Zhang *et al.*, 2023).
- MPs can adsorb heavy metals and organic pollutants, acting as vectors of contamination (Bayo *et al.*, 2025).
- Compost application contributes significantly to long-term soil pollution (Science of the Total Environment Review, 2025).

These findings highlight the role of composting systems in the environmental distribution of microplastics.



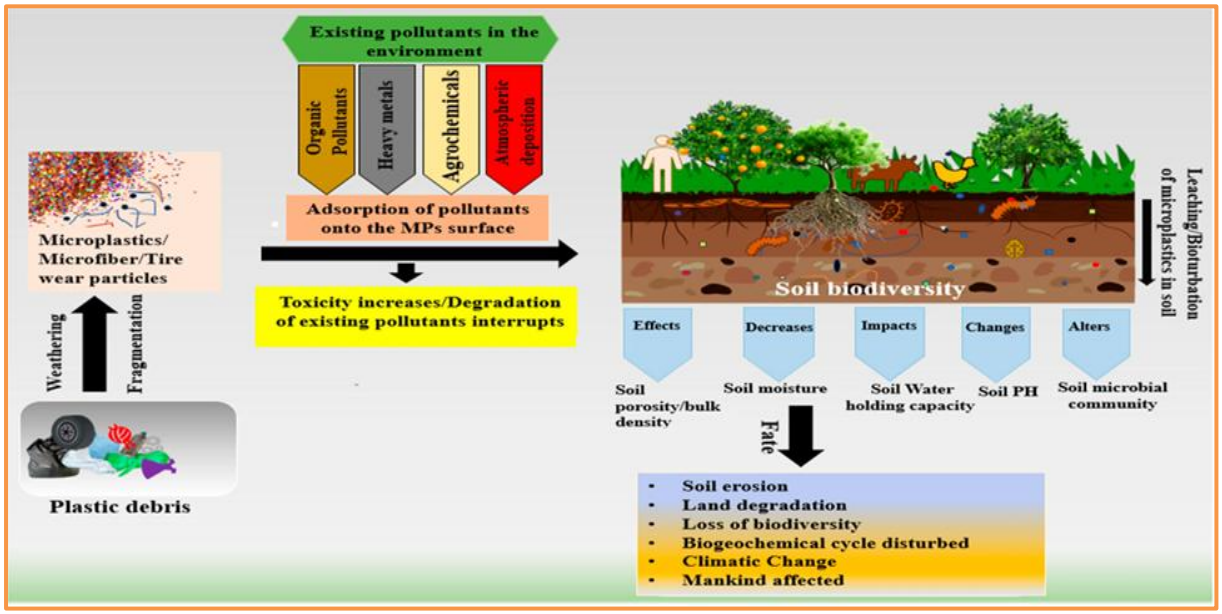
Organic waste streams as microplastic sources

Environmental and Ecological Impacts

Microplastics in organic waste systems have several ecological consequences:

- **Soil degradation:** MPs alter soil structure and reduce water retention capacity (Science of the Total Environment Review, 2025).
- **Microbial disruption:** They influence microbial diversity and enzymatic activity (Zhang *et al.*, 2023).
- **Toxicity:** MPs carry toxic substances such as heavy metals, increasing environmental risks (Bayo *et al.*, 2025).
- **Food chain contamination:** MPs can be taken up by plants and transferred through food webs (Ruffell *et al*., 2025).

These impacts collectively threaten soil health, biodiversity, and agricultural sustainability.



Impacts of microplastics on soil ecosystem functions

Challenges in Plastic Recycling

Microplastic contamination significantly affects plastic recycling systems:

- **Material contamination:** Mixed waste reduces the purity of recyclable plastics (*Geyer et al.*, 2017).
- **Sorting inefficiencies:** Improper segregation complicates recycling processes (MDPI, 2023).
- **Polymer degradation:** Fragmented plastics lose structural integrity, lowering recycling quality (Ruffell *et al*., 2025).
- **Economic limitations:** Contaminated plastics increase processing costs and reduce profitability (Geyer *et al.*, 2017).

These challenges demonstrate the limitations of current recycling infrastructure.

Waste Management and Policy Implications

Addressing microplastic contamination requires integrated waste management strategies:

- Improved **source segregation** (MDPI, 2023)
- Development of **effective biodegradable materials** (Ruffell *et al.*, 2025)
- Implementation of **monitoring standards for compost quality** (Zhang *et al.*, 2023)
- Promotion of **circular economy approaches** (Geyer *et al.*, 2017)

Public awareness and stricter regulations are essential to reduce plastic contamination in organic waste streams.

Conclusion

Microplastic contamination of organic waste is an emerging environmental challenge with significant implications for soil health and sustainability (Zhang *et al.*, 2023). Composting

systems, though beneficial, are increasingly recognized as pathways for microplastic transfer into terrestrial ecosystems (Ruffell *et al.*, 2025). The persistence of plastics during composting raises concerns about long-term environmental accumulation and ecological risks (Bayo *et al.*, 2025). Additionally, microplastics hinder recycling efficiency, further complicating waste management systems (Geyer *et al.*, 2017). Addressing this issue requires improved waste segregation, innovative materials, and stronger regulatory frameworks. Sustainable practices and global cooperation are essential to mitigate the impacts of microplastics and ensure environmental protection.

References

1. Bayo, J., Olmos, S., López-Castellanos, J. and Alcolea, A. 2025. Microplastics as vectors of environmental contaminants: implications for soil ecosystems. *Environmental Pollution.* 330: 121845.
2. Bläsing, M. and Amelung, W. 2018. Plastics in soil: analytical methods and possible sources. *Science of the Total Environment.* 612: 422–435.
3. Corradini, F., Meza, P., Eguiluz, R., Casado, F., Huerta-Lwanga, E. and Geissen, V. 2019. Evidence of microplastic accumulation in agricultural soils from sewage sludge disposal. *Science of the Total Environment.* 671: 411–420.
4. Geyer, R., Jambeck, J.R. and Law, K.L. 2017. Production, use, and fate of all plastics ever made. *Science Advances.* 3(7): e1700782.
5. MDPI. 2023. Microplastic contamination in organic waste and composting systems: sources, pathways, and mitigation strategies. *Sustainability.* 15(4): 3456.
6. Nizzetto, L., Futter, M. and Langaas, S. 2016. Are agricultural soils dumps for microplastics of urban origin? *Environmental Science & Technology.* 50(20): 10777–10779.
7. Rillig, M.C., Lehmann, A., Ryo, M. and Bergmann, J. 2019. Shaping up: toward considering the shape and form of pollutants. *Environmental Science & Technology.* 53(14): 7925–7926.
8. Ruffell, H., Møller, J. and Boldrin, A. 2025. Microplastics in organic waste treatment systems: occurrence, fate, and environmental implications. *Waste Management.* 160: 120–132.
9. Science of the Total Environment Review. 2025. Microplastics in soil systems: sources, transport, and ecological risks. *Science of the Total Environment.* 905: 167890.
10. Springer Study. 2026. Occurrence and fate of microplastics in wastewater treatment plants and biosolids. *Environmental Science and Pollution Research.* 33: 11245–11260.
11. van den Berg, P., Huerta-Lwanga, E., Corradini, F. and Geissen, V. 2020. Sewage sludge application as a vehicle for microplastics in eastern Spanish agricultural soils. *Environmental Pollution.* 261: 114198.
12. Zhang, C., Chen, X., Wang, J. and Tan, L. 2023. Microplastics in terrestrial ecosystems: sources, fate, and impacts on soil properties and biota. *Journal of Hazardous Materials.* 443: 130280.