Plastic particle mismanagement identified as key driver of environmental contamination

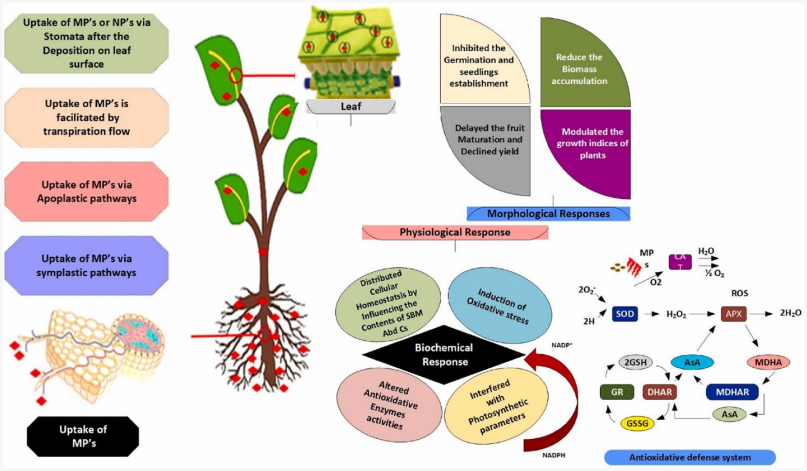
The accumulation and mismanagement of plastic fibers and particles remains a critical issue, threatening both human health and environmental sustainability.

SHARJAH, EMIRATE OF SHARJAH, UNITED ARAB EMIRATES, September 29, 2025 /EINPresswire.com/ -- The accumulation and poor management of plastic fibers and particles remains a pressing global issue, with serious consequences for both human health and environmental sustainability.

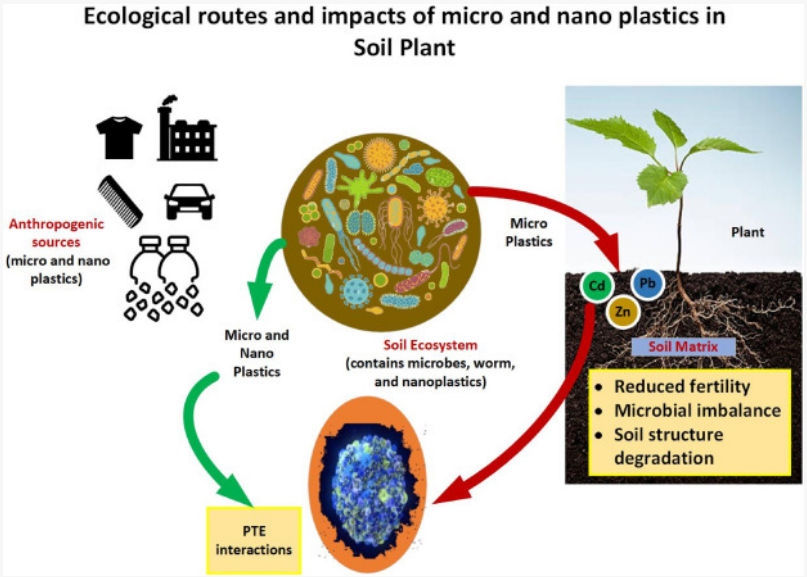
This conclusion is drawn from an analysis of peer-reviewed articles, review papers, and key reports published by international organizations between 2018 and 2025.

The study, published in the journal Environmental Research, looks at 228 key papers, all written in English and addressing environmental impacts, soil-microbe interactions, human health effects, and waste valorization technologies.

The analysis begins by identifying five key themes, which are categorized as ecological effects, contaminant interactions, management innovations, socio-economic implications, and



Sources and exposure pathways to micro nano plastic particles in terrestrial ecosystem agriculture. Credit: Environmental Research. DOI: https://doi.org/10.1016/j.envres.2025.122572



Interactions of micro (nano) plastics with PTEs and contribute to soil toxicity. Credit: Environmental Research. DOI: https://doi.org/10.1016/j.envres.2025.122572

policy interventions.

The research seeks to chart a course toward a plastic-free future by offering what the authors describe as “a holistic review” of microplastic accumulation and management, with a focus on land and environmental sustainability.

The authors highlight the significance of micro- and nano-plastics (MNPs), plastic particles or fibers ranging in size from nanometers to less than 5 millimeters, which are increasingly recognized as pervasive environmental pollutants.

“The accumulation and mismanagement of MNPs is concluded as a significant global problem in this review and it poses substantial negative impacts on human health and environmental sustainability,” the authors write.

“Effective strategies to mitigate MNP pollution demand circular economy approach that can reduce plastic production and consumption, promoting reuse and mechanical recycling over valorization and chemical recycling and adopting robust, sustainable waste management.”

The review paper offers a comprehensive analysis of the challenges and opportunities associated with managing micro- and nano-plastics within ecosystems.

It emphasizes the ecological impact of MNP contamination on soil–plant systems and its broader implications for individual health. The review explores how MNPs interact with living organisms, detailing their accumulation mechanisms in soil environments, their interactions with potentially toxic elements (PTEs), and the resulting risks of soil toxicity.

Additionally, it examines the effects of MNPs on crop health and the potential human health risks linked to the consumption of plants contaminated with these particles.

The authors, affiliated with Lahore College for Women University, Central Queensland University, University of Sharjah, University of Karachi, and the Environment and Protected Areas Authority in the UAE, present a sobering assessment of the threats micro- and nano-plastics (MNPs) pose to both human health and the environment.

They mention that more than 300 million tons of plastic are produced annually, of which approximately 50% is intended for single-use applications. They add that due to its extreme resistance to decomposition, often persisting for over a thousand years, plastic waste is widely mismanaged across the globe.

Plastic particles accumulate across landfills, water bodies, agricultural systems, such as mulching films and biofilms, and even in the atmosphere. This widespread presence underscores the growing severity of plastic pollution as a global environmental challenge.

This buildup, they say, is evident in landfills, water bodies, agricultural settings (such as mulching films and biofilms), and even in the air. As a result, plastic pollution has emerged as a major and increasingly urgent global environmental challenge, they maintain.

The study highlights that the presence of the bioaccumulation of micro- and nano-plastics in freshwater and marine ecosystems, along with their ingestion by various life forms, can contribute to declining health outcomes.

It underscores the need for developing appropriate infrastructure, promoting waste valorization, and implementing cost-effective strategies for plastic waste management. It also proposes practical solutions to reduce plastic pollution in the environment.

“In food chains, MPs pose risks to human health, with significant ingestion from contaminated sources potentially leading to oxidative stress and physiological disturbances in both humans and marine wildlife,” they note. “Repurposing plastic waste in construction enhances material properties and reduces environmental impact. Additionally, activated carbon from plastic waste shows strong pollutant adsorption capabilities, aiding environmental remediation.”

To stave off the risks, the study calls for the adoption of effective measures to mitigate the adverse impact of plastic particles and fibers on human health and the environment.

According to the authors, effectively addressing MNP pollution requires adopting a circular economy framework that prioritizes reducing plastic production and consumption. This approach emphasizes reuse and mechanical recycling over chemical recycling and valorization, while also advocating for resilient and sustainable waste management systems.

“Microplastics (MPs) interact with heavy metals, affecting plant biomass and chlorophyll levels—likely due to reduced metal bioavailability and shifts in microbial populations,” the authors note. Within food chains, they say, MPs pose significant risks to human health, as ingestion from contaminated sources may lead to oxidative stress and physiological disturbances in both humans and marine organisms.

They further highlight that repurposing plastic waste in construction not only enhances material performance but also reduces environmental impact. Moreover, activated carbon derived from plastic waste demonstrates strong pollutant adsorption capabilities, offering promising potential for environmental remediation.
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LEON BARKHO
University Of Sharjah
+971 501654376
email us here