Global Implications of Microplastic Pollution: Insights from Northern Irish Agricultural Soils

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ABSTRACT:
Agriculture underpins food production systems and food security, yet increasing evidence shows that microplastics (MPs, 1–5000 μm) are infiltrating soils and potentially entering the food chain. MPs can persist in soils, altering structure, nutrient cycling, and microbial communities, with consequences for crop health, productivity, and food quality. Uptake of MPs by crops and their transfer through the food system raise concerns for food safety, particularly in regions already challenged by climate-driven stresses. This study represents the first systematic assessment of MPs in agricultural soils in Northern Ireland, and the first in Europe to quantify MPs in pastoral soils. Soil samples (n = 150) were collected from ten sites using standardized rhizospheric sampling (0–20 cm). MPs were isolated via density separation and identified using μFTIR spectroscopy. Concentrations averaged 47.48 ± 4.13 particles kg^{-1} soil, significantly lower than global reports, with rayon microfibers and polyethylene fragments being the dominant types. Regional variability highlighted County Antrim as more diverse in polymer types, likely linked to historical textile activities and current agricultural plastic use. Atmospheric deposition was also identified as a potential contamination pathway. Although relatively low, the detection of MPs in NI agricultural soils has implications for food safety and food system resilience. MPs may compromise soil health, reduce crop yields, and represent an emerging contaminant in food chains. Importantly, Northern Ireland provides a valuable exemplar for understanding how soil-based MP pollution manifests in temperate agricultural systems, offering insights and transferable lessons with relevance to global food production landscapes. This baseline study underscores the urgent need for integrated research to assess long-term impacts of MPs on food safety, soil fertility, and ecosystem services. It further highlights the importance of targeted interventions such as reducing plastic inputs, adopting biodegradable materials, and strengthening waste management. These measures are critical for safeguarding soil functionality, ensuring safer food systems, and supporting food security in a climate-challenged era.

KEYWORDS:
Microplastics; Agricultural soils; Food safety; Food security; Sustainable agriculture; Climate resilience