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Agricultural plastic's application and problems

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The agronomic use of plastic film mulching (PFM) has been hugely successful in promoting food security and improving rural livelihoods. PFM has also enabled substantial increases in food production, farmer incomes, reduced pesticide use and improved water and nutrient use efficiencies. However, the resulting plastic pollution in soils (including macro-, micro- and nano-sized plastics) caused by PFM has attracted significant attention from scientists, regulators, policymakers and plastic manufacturers. While many articles have been published on the amount, behavior and fate of microplastics in soils, most of these studies are based on laboratory- and plot-scale experiments with extremely high concentrations of macro- and microplastics, resulting in over-exaggerated conclusions about the environmental risk of PFM use. Therefore, there remains a critical need to determine the effect of legacy PFM contamination in soil ecosystems at realistic field loading rates. Also, although biodegradable plastic film represents a promising way to help resolve the plastic pollution caused by conventional plastic film, the effect of biodegradable plastic film on soil microplastic concentration, soil microbial communities and the plant growth remains poorly understood. Therefore, the 10 articles in this special issue focus on the abundance and distribution of macro- and microplastics in soils, the effect of conventional and biodegradable plastic films on the soil environment and plant growth as well as the policy for plastic sustainable management.

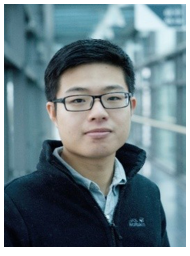
The abundance of macro- and microplastics in soils varies in different farming systems. Sun et al. (https://doi.org/10.15302/J-FASE-2025660) analyzed the concentration and polymer types of microplastics (MPs) and plastic additive of phthalate esters (PAEs) in soil samples collected at nine typical mulching regions from six provinces in China. The findings suggest that PFM is not the main contributor to MPs and PAEs in soils in these nine regions. Zhang et al. (https://doi.org/10.15302/J-FASE-2025627) investigated the dynamics of macroplastics and MPs in soils taken from different depths in cotton fields of Xinjiang Uygur Autonomous Region, China, after 5–30 years of PFM application. They found that the proportion of > 1 mm MPs decreased with soil depth, while the small MPs with size < 1 mm increased. Additionally, the mass of macroplastics was highly linked with MPs concentration.

The application of biodegradable plastic film is a potentially more sustainable alternative to conventional plastic film. Thanh et al. (https://doi.org/10.15302/J-FASE-2025623) investigated the effect of oxo-degradable macroplastics and MPs on soil quality and the growth of *Zea mays* and found that

the response was highly dependent on the concentrations of oxo-degradable macroplastics and MPs. Ren et al. (https://doi.org/10.15302/J-FASE-2025629) investigated the effect of biodegradable plastic films on MPs distribution and microbial communities in paddy soils, and found that the application of biodegradable plastic films altered the composition and abundance of MP-degrading bacterial communities. Samphire et al. (https://doi.org/10.15302/J-FASE-2025608) reported that the use of biodegradable plastic film over three years of organic horticultural production increased the yield but did not affect soil organic matter content. Thennakoon et al. (https://doi.org/10.15302/J-FASE-2025648) found that biodegradable mulch had similar performance with conventional plastic mulches on improving crop yield in Sri Lankan wet zone agriculture. Wu et al. (https://doi.org/10.15302/J-FASE-2025626) investigated the effect of different types of conventional and biodegradable MPs on pea growth and soil carbon and nitrogen content as well as soil microorganisms. Zhang et al. (https://doi.org/10.15302/J-FASE-2025642) summarized the effect of PFM and MPs on soil nitrogen cycling and suggest long-term experiments are necessary.

Plastic policy is critical to sustainable management of agricultural plastics. Wen et al. (https://doi.org/10.15302/J-FASE-2025625) reviewed the three main development phases of Chinese agricultural plastics management policy since 1982, summarized the positive and negative effects of agricultural plastics, and proposed targeted improvements to promote the sustainable management of agricultural plastics. Kassem et al. (https://doi.org/10.15302/J-FASE-2025621) investigated how farmers use agricultural plastic film (including plastic mulch and plastic covers) and manage their disposal by surveying 300 farmers in three governorates of Egypt. The results provided valuable insights for policymakers to develop collaborative management strategies for plastic disposal and recycling.

In summary, the articles in this special issue provide an overview on current status of agricultural plastic applications and existing problems of macroplastics and MPs. Guest Editors of this issue hope these studies will promote future research in this area, ensuring food security while avoiding or minimizing plastic pollution.



Kai Wang, Associate Professor of environmental chemistry at the College of Resources and Environmental Sciences, China Agricultural University. He obtained his PhD from Johannes Gutenberg University Mainz and Max Planck Graduate Center. His research mainly focuses on the chemical identification, fate and environmental effect of organic pollutants (e.g., microplastics and pesticides) in soils and atmosphere. He has published more than 50 peer-reviewed papers in international journals such as *Environmental Science & Technology*, *Environment International and Atmospheric Chemistry and Physics*. He is currently a Youth Editor Member of *Frontiers of Agricultural Science and Engineering* and a Founding Youth Editor of *Agricultural Environment and Sustainability*.

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Changrong Yan, Professor at the Chinese Academy of Agricultural Sciences, a recipient of the Special Government Allowance of the State Council and a National Distinguished Talent in Agricultural Research. His research focuses on the application and pollution prevention of agricultural plastic films. He has developed evaluation methods for assessing the suitability of mulching technologies for various crops and elucidated the distribution patterns and mechanistic effects of plastic film residues in farmland. Since 2010, he has led over 10 major national and international research projects, including key programs supported by Ministry of Science and Technology of China, Ministry of Agriculture and Rural Affairs of China, National Natural Science Foundation of China and a Sino-UK Joint Project funded by both governments, and initiatives under the UK Global Challenges Research Fund. He has coauthored 18 books, published more than 100 papers and received numerous prestigious awards at the national, ministerial and provincial levels.

Fan Ding, Professor of Soil Ecology and Environment at Shenyang Agricultural University, China. His research directions included environmental consequence of plastic film mulch residues and soil organic matter sequestration. He co-authored more than 50 papers (including in *Environmental Science & Technology* and *Global Change Biology*), of which five are in Clarivate's Essential Science Indicators Database as highly cited papers. He has been principal investigator for National Key Research and Development Young Scientists Project, the UK Global Challenge Research Fund (co-principal investigator) and the National Natural Science Foundation. He serves as a young member of the Microplastics Working Group of the Chinese Society of Soil Science, a young member of the Soil Environment Professional Committee of the Chinese Society of Soil Science. He is on the editorial boards of *Science of the Total Environment* and *Hunan Ecology Science Journal*, and is on the youth editorial board for *Carbon Research*, *Biochar* and some others.

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Dave R. Chadwick, Professor of Sustainable Land Use Systems at Bangor University. His research focuses on the management of nutrients in livestock manures, other organic resources and fertilizers to optimize nutrient utilization while minimizing impacts on water and air quality. This includes quantifying and mitigating greenhouse gas emissions, reducing the risk of transfers of pollutants to watercourses and understanding the secondary impacts of mitigating diffuse agricultural pollution. Recent research includes exploring the balance between the societal use of agriplastics and their potential impacts on soil and crop health. He has published > 350 peer-reviewed papers in international journals including *Nature Food*, *Nature Sustainability*, and *Nature Climate Change*.

Davey L. Jones, Professor of Environment Science and Public Health at Bangor University. He obtained his PhD from Oxford University. His research mainly focuses on understanding belowground processes with specific focus on nutrients and human pathogen behavior in water-food-soil-plant-microbial systems. He has published 778 peer-reviewed papers in international journals such as *Nature*, *Nature Plants*, *Nature Geoscience*, and *Nature Communications*. He is currently Chief Editor for *Frontiers in Soil Science* and Section Editor for *Frontiers in Agronomy*.