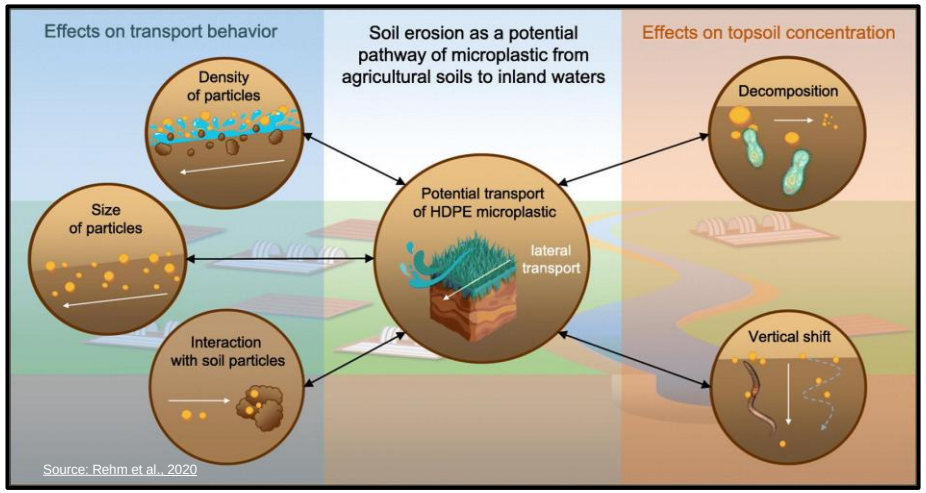
Microplastics in agricultural soils – A growing concern?

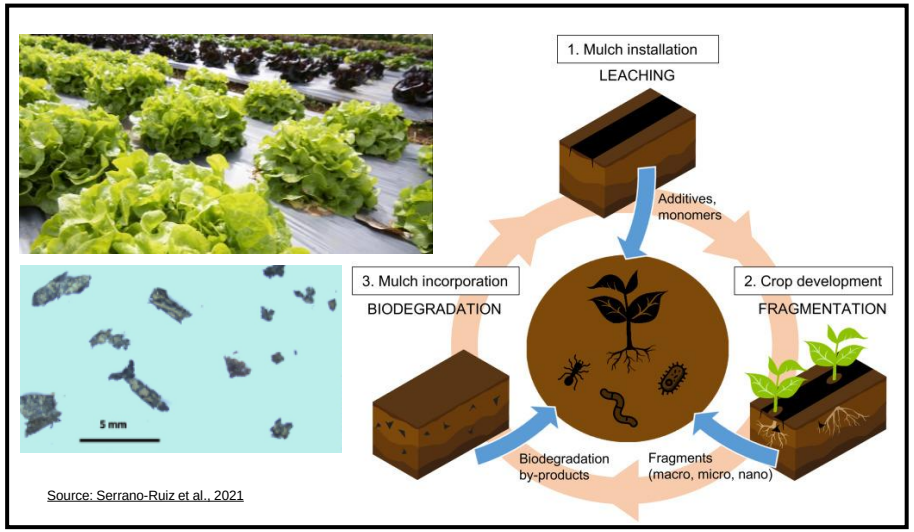
Plastics are versatile, easy-to-handle, and low-cost synthetic materials made from polymers, essential in industries like packaging, automotive, construction, and healthcare. Global plastic production has reached 368 million tons, as reported in 2019 (1). In agriculture, plastics boost productivity through applications like mulches, greenhouse films, and irrigation systems, helping conserve soil moisture and heat, reduce weeds, and improve water efficiency. However, improper disposal and overuse of plastics lead to severe environmental harm. Plastics persist for centuries, breaking into microplastics - tiny particles under 5 millimeters from degraded plastics. These microplastics spread through wind, water, and atmospheric deposition, cause widespread pollution.



It is reported that the total amount of microplastics in the terrestrial system might be 4 to 23-fold higher than that in the ocean (2). Therefore, microplastic pollution in agricultural soil can not be neglected. Microplastics can accumulate in crops, alter soil structure, reduce fertility, harm soil organisms, harm human health through food chain contamination, and endanger wildlife through ingestion, making microplastic pollution a growing concern that requires urgent attention.

Microplastics (MP) infiltrate agricultural soils through diverse pathways. Plastic mulches leave behind post-harvest residues. Due to such mulching film residues, reported microplastic concentrations are up to 2200 microplastic particles per kg of soil. Sewage sludge, commonly employed as fertilizer in the EU (4 million tons annually), also introduces microplastics to agricultural fields, with concentrations reaching up to 2200 particles per kg of soil.

Research shows a range of 1100–3500 MP per kg in agricultural fields in Chile and in average 5190 MP particles per kg in Spain. Industrial compost application in agriculture is also considered a significant contributor of plastics in soils (e.g., research has shown 1750 MP particles per kg in the Netherlands and 2400 MP particles per kg in China). Other sources are greenhouses (1000 to 3786 MP particles per kg at farms where greenhouses were first used in the 1980s), fertilizers (6–369 mg of plastics per kg of soil in fields, where coated fertilizers were used), manure (1250 ± 640 MP particles per kg of dry manure), polytunnels, shade nets, wind barriers, fertilizers and pesticides, improper storage of plastic products (2).

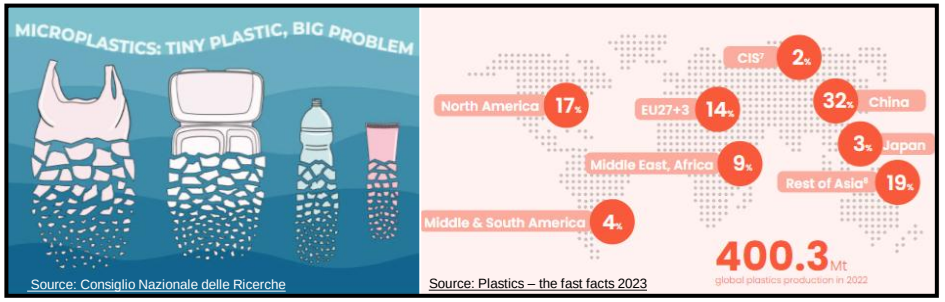


Source: Serrano-Ruiz et al., 2021

Plastic mulches contribute significantly to plastic pollution due to the difficulty of recovering all fragments and low recycling rates below 30%. Once buried, they degrade slowly, leading to persistent fragments that harm soil health and crop yield. Additives in plastic mulches can leach into the soil. Repeated use releases fragments and chemicals, threatening agricultural and natural ecosystems, with around 80% of non-degradable mulch waste accumulating in nature.

Biodegradable plastics aim to reduce this waste by saving time and costs in managing fragments. However, concerns include incomplete degradation and the leaching of additives and intermediates. While biodegradable mulches reduce long-term waste, they pose risks of fragment accumulation and chemical leaching. Though cost-effective and durable, traditional mulches contribute to significant pollution and require labor for removal. The choice between them depends on balancing immediate economic benefits with long-term environmental impacts.

Biodegradable mulch films decompose within months to years under optimal conditions, while non-biodegradable films persist for centuries, fragmenting into microplastics. Concerns about biodegradable films include their degradation rate, potential fragment accumulation, and chemical leaching. Further research is needed to ensure their performance and to explore sustainable alternatives.



To combat plastic pollution, it's crucial that we all come together as a community.

- By prioritizing biodegradable alternatives to traditional mulches, optimizing plastic use, and promoting reusable materials, we can significantly reduce our environmental footprint.
- Emphasizing sustainable products, avoiding single-use plastics, and supporting eco-friendly brands, we can contribute to a healthier planet.
- Advocating for microplastic prohibition in cosmetics, enhancing recycling systems, and organizing community clean-ups, we can actively participate in the solution.
- Policy changes, education, and innovative materials are essential, and our collective efforts can alleviate pollution, protect soil, and promote environmental consciousness.
- Farmers, in particular, can play a crucial role by adopting reusable mulches, organic weed control, and integrated pest management. Precision agriculture, composting, and recycling further reduce plastic pollution while advancing sustainability in agriculture.
- Citizen science engages communities in monitoring and cleanup, fostering awareness. Integrating farmer and citizen science initiatives effectively addresses plastic pollution locally and globally.

(1) Europe, P. (2017). Plastics-the Facts 2017 An analysis of European plastics production, demand and waste data. *Available on the website: http://www. plasticseurope. org*.
(2) Lwanga, E. H., Beriot, N., Corradini, F., Silva, V., Yang, X., Baartman, J., ... & Geissen, V. (2022). Review of microplastic sources, transport pathways and correlations with other soil stressors: a journey from agricultural sites into the environment. *Chemical and Biological Technologies in Agriculture*, *9*(1), 20.
(3) Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science advances*, *3*(7), e1700782.

We acknowledge that the SOPLAS project, funded by the EU under Horizon 2020 (Grant No 955334), enhances our understanding of agricultural plastic pollution.

soplas