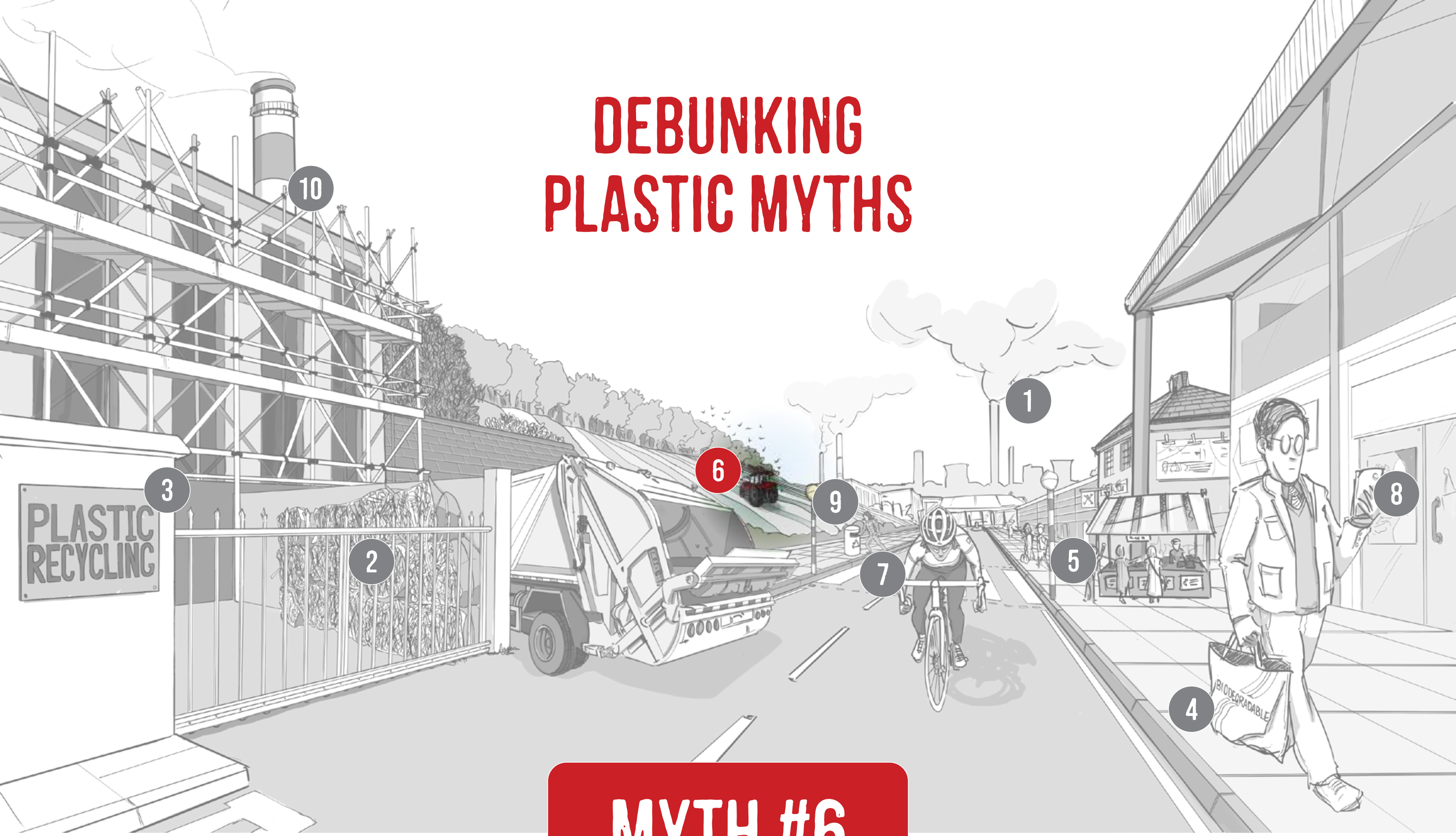
DEBUNKING PLASTIC MYTHS



MYTH #6

PLASTICS IN AGRICULTURE CAUSE LITTLE HARM

On-farm uses of plastics include greenhouses, wind tunnels, low tunnels, shade cloth, protective mesh, irrigation tape, drainage tubing, mulch films, containers, and more. In 2021, agriculture used an estimated 12.5 million tonnes of plastic (FAO, 2021). Farmers use plastic because it is inexpensive and convenient, but most products have a short and linear life cycle of only one season (Vox et al., 2016). Only a small proportion of agricultural plastics are recycled, with recycling generally limited to developed countries. However, in most places waste plastic is typically burned, buried, or left on the ground to decompose by the sun and wind (FAO, 2021).

The presence of plastic in agricultural soil was first identified nearly 20 years ago (Rillig, 2012), and a growing body of research indicates that concentrations are increasing in areas of intensive agriculture (Zhou et al., 2020). Plastic particles can end up in the soil from the breakdown of plastic products or from the use of products unintentionally contaminated with plastic particles. Evidence suggests that a build-up of plastic particles can have wide-ranging impacts on soil health and biodiversity. If concentrations continue to increase, then declines in soil productivity could affect food security. This threat comes in the context of a projection that feeding the world's population in 2050 will require a 50 per cent increase in available food production (UNEP, 2019).

Sources of microplastics in agriculture

The amount of agricultural plastic entering the environment is currently unknown, but the main sources of plastic in soil have been identified as fertilizer produced as a biproduct from wastewater, mulch films, and polymer-coated fertilizers.

Sewage sludge and biosolids are used around the world as fertilizer for their high levels of plant nutrients. Recycling these nutrients back into soil is desirable, but wastewater treatment processes do not effectively remove microplastics and other contaminants from the sewage and concentrate them in the sludge. A recent study estimated that nearly 4,000 tonnes of microplastics from biosolids end up on agricultural land every year in Australia (Okoffo et al., 2020).

Common plastic films, which are used in agriculture for mulch, are made from low-density polyethylene (LDPE), a non-biodegradable mulch largely produced from petroleum. The mulch, which helps conserve moisture and suppress weeds, is designed to be removed post-harvest, but often some is left and incorporated into the soil during subsequent soil preparation (Kasirajan & Ngouajio, 2012). In areas with widespread and long-term use of LDPE plastic mulch, plastic particles can accumulate in soils (Huang et al., 2020). A 2010 study* found that in areas where mulch had been used for more than 10 years, the residual plastic levels in topsoil were 50–260 kg per hectare. As an alternative to LDPE mulch, farmers can use biodegradable mulch (BDM). After harvest, this mulch is tilled into the soil where microorganisms are supposed to break it down. BDM is a more sustainable but there are concerns regarding the time and conditions needed for complete biodegradation (van der Zee, 2021).

Plastic polymer encapsulated controlled release fertilizers are another potential source of soil contamination (Bläsing & Amelung, 2018; Qi et al., 2020; Katsumi et al., 2021). The fertilizer can be coated with a variety of polymers some of which are not biodegradable and build up in the soil. As with BDM, however, there is currently considerable research into improving biodegradability.

The environmental costs

The impact of microplastic accumulation in agricultural soil is poorly understood, but is likely to cause some of the same harmful effects of microplastics in other environments (FAO and UNEP, 2021). There is some evidence that microplastics can affect microbial communities, soil invertebrates, and the physical properties of soil, depending on the size of the particles and the exposure level (Mbachu et al., 2021). The available studies suggest that the observed changes in physiochemical properties such as soil structure, water-holding capacity, density can affect plant growth (Rillig et al., 2019 and refs. therein).

Surface run-off and erosion can transport microplastics from fields. The size and shape of the particles influence their transport pathway and fate, but like leached nutrients, they are expected to end up in waterways. Microplastics can also migrate from the surface deeper into the soil profile, facilitated by field preparation, bioturbating organisms, and drainage. The fate of microplastics once in the soil is poorly understood as there is no information on average residence time or turnover (Rillig & Lehmann, 2020), but at least some microplastics are likely to infiltrate groundwater (O'Connor et al., 2019).

* The original article by Yan, He and Mei in Chinese was unavailable but it is referenced in Liu et al. (2014).

What can we do?

The continued poor management of agricultural plastics and the lack of recognized available non-contaminating alternatives will lead to ever-increasing levels of microplastics in soil. Maintaining soil as a healthy productive living ecosystem is directly linked to the health of people and animals. While the long-term implications of microplastics in soil are scarcely understood, researchers are warning that they could pose a significant threat to sustainable food production (Lin et al., 2020). Among the possible solutions to the risks posed by plastics in agriculture are the development of policy tools, and the adoption of eco-design, alternative technologies, and nature-based alternatives.

1. Develop policy tools that improve the efficiency of waste management systems and minimize the impact of plastic waste

The 2018 European Strategy for Plastics in a Circular Economy is prompting Member Countries to consider introducing fiscal measures and organizing, at the national levels, Extended Producer Responsibility (EPR) schemes to reduce plastic littering and boost recycling (EC, 2018). For the agricultural sector, the approach to implementing the strategy might include traditional market-based policy tools – subsidies and tax-credits – and a payback mechanism under EPR to reduce plastic waste in agriculture (De Lucia & Pazianza, 2019). An EPR scheme may serve as an ad hoc policy instrument that can significantly help European waste management minimize the impact of plastic use (Filho et al., 2019). These schemes consider a producer's responsibility extended to the final phase of consumption activities including recycling, take-back and final disposal of waste material (OECD, 2014).

These policy concepts are under consideration and already in operation in some regions, particularly in northern European countries (Hennlock et al., 2014). The empirical evidence shows that the economic tools have promoted plastic waste recycling initiatives in a more useful way and have increased the rate of successful results. In addition, combining the adoption of advanced technology in the production processes with economic incentives may help reduce plastic waste in agriculture and create spillover effects along the entire supply chain (De Corato & Cancellera, 2019).

2. Adopt eco-design and alternative technologies

The plastic commonly used in non-biodegradable mulch is rarely recycled because of its thinness and contamination with pesticides, dirt, and fertilizers. Collection and processing of this material is labour-intensive and expensive to reuse or recycle. Thicker plastic mulch is more expensive, but stands a better chance of being recycled. Some places use take-back systems or other disposal options. These eco-designs can make recycling easier for farmers and avoid damaging the environment.

The use of biodegradable plastic mulch is slowly increasing, but farmers need to be able to depend on the biodegradability under agricultural conditions, and so improved standards and regulations become necessary. Given that biodegradability is just an additional feature of the material to be exploited at the end-of-life (Rujnić-Sokele & Pilipović, 2017), biodegradable plastics should be incorporated into EPR schemes. To be effective, only certified biodegradable plastics should be exempted from EPR collection and treatment costs (Hann et al., 2021).

3. Adopt nature-based alternatives

Farmers can avoid the potential impact of plastic mulches by choosing sustainable alternatives such as natural mulches or cover crops, which have historically been used to preserve moisture, regulate soil temperature, discourage weeds and improve soil organic content (Haapala et al., 2014). The perception of higher costs associated with nature-based farming may be a barrier, but evidence suggests that the initial higher costs can be offset by savings – less time and money spent on pesticides, for example (Sanders et al., 2017). Farmers may find that consumer demand for more sustainably produced products outweighs any additional costs of the natural alternatives.

From the public policy perspective, a true comparison of the costs and benefits of the different approaches would have to consider the effects on ecosystem services of the alternatives in a way that may be irrelevant to individual farmers. Where the nature-based systems confer substantial ecosystem services benefits over the long run, public policy should support farmers in making the transition so that the public gets the benefits of improved ecosystem services, but the farmers do not have to bear the burden themselves.

References

Bläsing, M., & Amelung, W. (2018). Plastics in soil: Analytical methods and possible sources. Science of the Total Environment. Elsevier B.V., pp. 422–435. doi: 10.1016/j.scitotenv.2017.08.086.

De Corato, U., & Cancellara, F. (2019). Measures, technologies, and incentives for cleaning the minimally processed fruits and vegetables supply chain in the Italian food industry. Journal Of Cleaner Production, 237, 117735. doi: 10.1016/j.jclepro.2019.117735

De Lucia, C., & Pazienza, P. (2019). Market-based tools for a plastic waste reduction policy in agriculture: A case study in the south of Italy. Journal Of Environmental Management, 250, 109468. doi: 10.1016/j.jenvman.2019.109468

European Commission. (2018). A European Strategy for Plastics in a Circular Economy. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A28%3AFIN

FAO. (2021). Assessment of agricultural plastics and their sustainability – A call for action. Rome. https://www.fao.org/publications/card/en/c/CB7856EN/

FAO and UNEP. /2021). Global Assessment of Soil Pollution: Report. Rome. https://doi.org/10.4060/cb4894en

Filho, W., Saari, U., Fedoruk, M., Iital, A., Moora, H., Klöga, M., & Voronova, V. (2019). An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. Journal Of Cleaner Production, 214, 550–558. doi: 10.1016/j.jclepro.2018.12.256

Hann, S., Fletcher, E., Sherrington, C., Molteno, S., & Elliott, L. (2021). Conventional and Biodegradable Plastics in Agriculture. Retrieved 3 February 2022, from https://www.eunomia.co.uk/reports-tools/conventional-and-biodegradable-plastics-in-agriculture/

Hennlock, M., zu Castell Rüdenhausen, M., Wahlström, M., Kjær, B., Milios, L., Vea, E., Watson, D., Hanssen, O. J., Fråne, A., Stenmarck, A., & Tekie H. (2014). Economic Policy Instruments for Plastic Waste—A Review with Nordic Perspectives. Nordic Council of Ministers, Copenhagen. https://www.norden.org/en/publication/economic-policy-instruments-plastic-waste

Haapala, T., Palonen, P., Korpela, A. & Ahokas, J. (2014). Feasibility of paper mulches in crop production - A review. Agricultural and Food Science 23(1), 60–79. https://doi.org/10.23986/afsci.8542.

Huang, Y., Liu, Q., Jia, W., Yan, C., & Wang, J. (2020). Agricultural plastic mulching as a source of microplastics in the terrestrial environment. Environmental Pollution, 260, 114096. doi: 10.1016/j.envpol.2020.114096

Katsumi, N., Kusube, T., Nagao, S., & Okochi, H. (2021). Accumulation of microcapsules derived from coated fertilizer in paddy fields. Chemosphere, 267, 129185. doi: 10.1016/j.chemosphere.2020.129185

Kasirajan, S., & Ngouajio, M. (2013). Erratum to: Polyethylene and biodegradable mulches for agricultural applications: a review. Agronomy For Sustainable Development, 33(2), 443–443. doi: 10.1007/s13593-012-0132-7

Lin, D., Yang, G., Dou, P., Qian, S., Zhao, L., Yang, Y. & Fanin, N. (2020). Microplastics negatively affect soil fauna but stimulate microbial activity: insights from a field-based microplastic addition experiment. Proceedings of the Royal Society B, 287(1934), p.20201268.

Liu, E. K., He, W. Q., & Yan, C. R. (2014). 'White revolution' to 'white pollution'—agricultural plastic film mulch in China. Environmental Research Letters, 9(9). doi: 10.1088/1748-9326/9/9/091001.

Mbachu, O., Jenkins, G., Kaparaju, P., & Pratt, C., 2021. The rise of artificial soil carbon inputs: Reviewing microplastic pollution effects in the soil environment. Science of The Total Environment, 780, p.146569.

O'Connor, D., Pan, S., Shen, Z., Song, Y., Jin, Y., Wu, W.M. & Hou, D. (2019). Microplastics undergo accelerated vertical migration in sand soil due to small size and wet-dry cycles. Environmental Pollution, 249, pp.527–534

OECD. (2014). The state of play on extended producer responsibility (EPR): opportunities and challenges OECD. Paris https://www.oecd.org/environment/waste/Global%20Forum%20Tokyo%20Issues%20Paper%2030-5-2014.pdf

Okoffo, E.D., Tscharke, B.J., O'Brien, J.W., O'Brien, S., Ribeiro, F., Burrows, S.D., Choi, P.M., Wang, X., Mueller, J.F., & Thomas, K.V. (2020). Release of plastics to Australian land from biosolids end-use. Environmental Science & Technology, 54(23), pp.15132–15141.

Rillig, M.C. (2012). Microplastic in terrestrial ecosystems and the soil? ACS Publications.

Rillig, M.C., & Lehmann, A., (2020). Microplastic in terrestrial ecosystems. Science, 368(6498), pp.1430–1431.

Rillig, M.C., Lehmann, A., de Souza Machado, A.A., & Yang, G. (2019). Microplastic effects on plants. New Phytologist 223(3), 1066–1070. https://doi.org/10.1111/nph.15794.

Rujnić-Sokele, M., & Pilipović, A. (2017). Challenges and opportunities of biodegradable plastics: A mini review. Waste Management & Research: The Journal for a Sustainable Circular Economy, 35(2), 132–140. doi: 10.1177/0734242x16683272

Sanders, Z.P., Andrews, J.S., Saha, U.K., Vencill, W., Lee, R.D., & Hill, N.S. (2017). Optimizing agronomic practices for clover persistence and corn yield in a white clover-corn living mulch system. Agronomy Journal 109(5), 2025–2032. doi: 10.2134/agronj2017.02.0106.

UNEP. (2019). Ekins, P., Gupta, J. and Boileau, P., (eds). Global Environment Outlook–GEO-6: healthy planet, healthy people.

van der Zee, M. (2021). Biodegradability of biodegradable mulch film: A review of the scientific literature on the biodegradability of materials used for biodegradable mulch film (No. 2138). Wageningen Food & Biobased Research.

Vox, G., Loisi, R.V., Blanco, I., Mugnozza, G.S., & Schettini, E. (2016). Mapping of agriculture plastic waste. Agriculture and Agricultural Science Procedia 8, 583–591. doi: 10.1016/j.aaspro.2016.02.080.

Zhou, Y., Wang, J., Zou, M., Jia, Z., & Zhou, S. (2020). Microplastics in soils: A review of methods, occurrence, fate, transport, ecological and environmental risks. Science of The Total Environment, p.141368.

Qi, Y., Beriot, N., Gort, G., Huerta Lwanga, E., Gooren, H., Yang, X., & Geissen, V. (2020). Impact of plastic mulch film debris on soil physicochemical and hydrological properties. Environmental Pollution, 266, 115097. doi: 10.1016/j.envpol.2020.115097

Recommended citation: GRID-Arendal (2022, March 15). Plastic Myths – What can we do? Website. https://plasticsmyths.com/