LETTERS

Plastics used in agriculture can lead to soil contamination.

*Edited by* **Jennifer Sills**

# Soil microplastics pollution in agriculture

Soil microplastics contaminate the soil when macroplastics used in farming decompose, threatening both agriculture and human health (*1*). Demand for agricultural plastics to regulate field climate is estimated to increase by 50% by 2030 (*2*). Emergency action is required to mitigate soil microplastics pollution and to help guide sustainable agricultural production.

Frequent extreme weather and growing food demand have exacerbated reliance on plastics to increase grain yield (*3*). Plastics used in agriculture include greenhouses and plastic films for temperature control, irrigation pipes, and seed plastic coating to prevent pests and diseases. When these plastics are left to decompose in the fields, microplastics enter the soil (*4*), decreasing the number, diversity, movement, and reproduction rate of soil biota (*5*). Microplastics can also change the physiochemical properties of soil, such as its structure, water-holding capacity, and density (*6*), which could restrict root growth, nutrient uptake, and yield of future crops (*7*).

Soil microplastics can be transferred to humans through the food chain or water cycle (*8*). Microplastic particles have been found in human intestines, lungs, blood, brain, and breast milk (*9*). These foreign substances can cause tissue rejection and inflammation, similar to the impact of particulate matter of less than 2.5 μm on the human respiratory system (*10*). Moreover, most compounds added to plastics, such as plasticizers, stabilizers, and pigments, are harmful to the human endocrine system (*11*).

Mitigating the damages of soil microplastics in farmland will require comprehensive action, including research, production, administration, and legislation. The global soil microplastics content in farmland caused by agricultural plastics must be quantified by combining long-term field monitoring, satellite remote sensing, and theoretical modeling. The potential damages of soil microplastics to land productivity, soil and field biodiversity, and human health must be determined. The site-specific maximum threshold for agricultural plastics use must be determined, especially in key agricultural regions with high microplastics content. Coordinated action plans such as consistent monitoring and assessment, global and cross-sectoral cooperation, and open data sharing are urgently required. Governments should encourage the transition to affordable biodegradable plastics through policy incentives, technological innovation, agricultural subsidies, public outreach, and collaboration with other stakeholders such as nongovernmental organizations, scientists, and industry. Farmers should receive incentives to explore nature-based farm equipment, phase out single-use plastic film, and prioritize reusable plastic products. Scientists should work to create affordable biodegradable agricultural plastic options and technology that can remove microplastics from the soil. Finally, legislation must be passed to regulate the use of agricultural plastics and the level of microplastics pollution in soil.

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# Understanding the limits of AI coding

In the 9 December 2022 issue, the Research Article "Competition-level code generation with AlphaCode" (Y. Li *et al.*, p. 1092) and the accompanying Perspective, "AlphaCode and 'data-driven' programming" (J. Z. Kolter, p. 1056) describe an artificial intelligence (AI)–based system for generating code. The authors explain that the system can be used for small coding problems, such as tests for computing students, and that they are far from being useful in computing applications that include millions of lines of code, such as word processing. As we enter an era of AI where tools like AlphaCode and chatGPT will change how tasks are performed, it is important to understand the boundaries of what they can and cannot do.

To make sure that code can be maintained and managed by other programmers, human developers use mnemonic variable names and embed explanatory comments. Understanding, debugging, and extending code written by other humans remains a formidable challenge—perhaps even more difficult than producing the code in the first place. In addition, many techniques are used for validation and verification, and code used in mission-critical applications, such as airline flight systems, goes through substantial quality assurance testing. AI models have yet to address the challenges of maintaining code, ensuring that users can decipher it, and subjecting programs to safety protocols.

Understanding and evaluating the limits of these techniques is crucial before they are put into real-world use. Some testing of capabilities has been applied to language generation tools (*1*, *2*), but AI coding remains a nascent field. The Technology Policy Committee of the Association for Computing Machinery recommends more investment in transparency and accountability for AI algorithms (*3*). The promise of systems like AlphaCode must be carefully balanced against the risks of their use. The interaction between AI code-generation systems and human programmers must be resolved before such systems can become an integral part of the future of computing.

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# Effective implementation of new biodiversity pact

In his *Science* Insider piece "New biodiversity pact sets ambitious goals, but will nations deliver?" (22 December 2022, https://scim.ag/1jG). E. Stokstad explains that the Kunming-Montréal Global Biodiversity Framework (GBF) of the Convention on Biological Diversity (CBD) is scientifically strong but legally weak. The GBF lacks hallmarks of effective international agreements, such as reciprocal responsibilities, dispute resolution systems, uncompromisable goals, and noncompliance penalties. For the GBF to be effective, these shortfalls must be addressed.

As Stokstad reports, the GBF aims to protect 30% of all lands and oceans, but the goal is global rather than national, which makes accountability difficult. Countries such as Brazil, Indonesia, and the Democratic Republic of Congo, which have more than 30% rainforest cover, are likely to continue current rapid deforestation (*1*). Moreover, because conservation goals pertain to all ecosystems and do not prioritize biodiverse areas, a country could declare rangelands as protected areas while continuing to allow logging in rainforests. Countries could also allow areas to be logged or cleared before declaring them as national parks, as has happened in Australia (*2*). The wording of the GBF (*3*) would allow countries to count the national park toward the target for protected land and then restore the area and count it again, this time toward GBF's separate target for restoration.

The GBF multilateral fund of US$30 billion per year (*4*) is more than 10 times the aggregate budgets of all developing-country parks agencies worldwide (*5*), and it could enable them to fund new land purchases, protection, and anti-poaching measures. However, these funds represent a transfer of just 0.1% of international trade (*6*) and just 0.03% of global gross national product (*7*) from taxpayers in developed nations to governments in developing nations. Meanwhile, multinational corporations that primarily serve wealthy countries continue to exploit developing countries' natural resources.

The framework provides for an additional US$170 billion per year for biodiversity funding within each country's own borders (*4*), including mechanisms such as ecosystem services payments and the purchase and protection of unprotected land of high conservation value to compensate for biodiversity loss elsewhere. However, such purchases, known as biodiversity offsets, are subject to political manipulation and largely unsuccessful (*8*). Offsets have even been claimed within an existing national park (*9*), already fully protected by law.

The US$30 billion per year the GBF international fund will be distributed through the Global Environment Facility (*4*). This new GBF sum is more than 80 times Global Environment Facility's 2022 to 2026 biodiversity allocation (*10*). Most Global Environment Facility funds go to newly industrialized rather than developing nations, and there is a risk that the organization will disseminate GBF funds similarly.

To strengthen the GBF, all financial transfers during its implementation need auditable accounting. Every new protected area needs internationally transparent boundaries, budgets, standards, and monitoring; the World Heritage model (*11*, *12*) could serve as an example. Penalties are needed for noncompliance. For example, countries that declare reserves but don't protect them could be charged a levy on exports, used to fund new reserves elsewhere. CBD could require these as conditions of GBF funds, with additional monitoring by nongovernmental organizations and research scientists.

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