Plastic in Agriculture: Are Soil-Biodegradable Mulches the Sustainable Answer?

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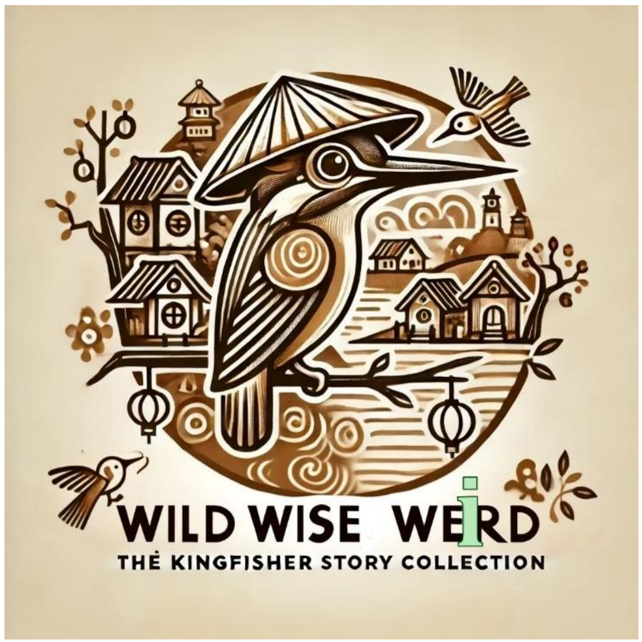
31-03-2025



"It has been indeed difficult to have both the precious pearl and his peaceful life."

In "Luck"; *Wild Wise Weird* [1]

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Agricultural mulch films—those thin plastic layers often seen blanketing fields of strawberries, tomatoes, or other high-value crops—have long played a vital role in enhancing farm productivity. By conserving soil moisture, suppressing weed growth, and boosting crop yields, these films have become essential tools in modern agriculture. However, conventional plastic mulches (PMs), typically made from fossil-derived polymers like polyethylene, have raised significant environmental concerns due to their persistence in soils and the challenges associated with their disposal [2].

In response, soil-biodegradable mulch films (BDMs), derived from plant-based or biodegradable polymers, have emerged as a promising alternative. The review of Dada et al. [3] critically examines whether BDMs can serve as a more sustainable option by employing a life cycle assessment (LCA) approach to evaluate the environmental impacts of both PMs and BDMs across their full life cycle—from manufacturing and field application to end-of-life (EOL) management. The review provides three main findings:

- Manufacturing Phase – A Major Contributor: The production stage accounts for the largest share of the environmental burden for both mulch types. While BDMs—particularly those made from starch—typically require less fossil energy and emit fewer greenhouse gases (GHGs), they often exhibit higher eutrophication potential (EUP) and greater land-use demands due to the agricultural inputs required to produce their feedstocks [4].
- Field Application – Comparable Agronomic Benefits, Reduced Emissions: In terms of crop productivity, BDMs generally perform on par with traditional PMs. However, BDMs offer environmental advantages by degrading directly in the soil, thereby reducing global warming potential (GWP) and eliminating the need for costly retrieval. In contrast, PMs can fragment into persistent microplastics, which accumulate in soils and may infiltrate food systems, posing long-term ecological risks.
- End-of-Life – A Critical Differentiator: Disposal practices significantly influence environmental outcomes. Traditional PMs are often landfilled or incinerated, generating toxic emissions and contributing to climate change. While mechanical recycling is a preferable strategy, it is costly and challenged by contamination. BDMs, by contrast, can undergo in-situ biodegradation, circumventing the need for post-use collection and reducing overall waste. Nevertheless, concerns remain regarding their long-term effects on soil microbial communities and ecosystem health.

While BDMs are not without limitations—particularly related to high production costs, feedstock sourcing, and biodegradation variability—they offer a tangible pathway toward more sustainable agroecosystems [5]. Unlike their plastic counterparts that linger for centuries, BDMs are designed to return to the earth, aligning agricultural practices more closely with natural regenerative cycles.

References

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