



# Improved End-Of-Life of Plastic Mulches

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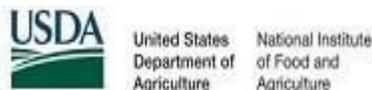
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## Synopsis:

Soil-biodegradable mulches (BDMs) are increasingly used in agriculture to replace conventional plastic mulch. This is an introduction to the impact of BDM on soil health and quality.

This material is based upon work supported by USDA SCRI award numbers 2022-51181-38325, 2019-51181-30012 & 2014-51181-22382, and Western Sustainable Agriculture Research and Education, under award no. WPDP19-05. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.



## Impact of Soil-biodegradable Plastic Mulch on Soil Health and Quality

*These notes provide information for presenters for this slide presentation on effects of biodegradable mulches (BDMs) on soil health and quality. Numbers in the text correspond to the slides in the presentation. Information in this document was summarized from publications listed in the Reference section.*

1. This presentation provides information on the impact of repeated use of soil-biodegradable mulch on soil health and quality.
2. Soils are foundational to numerous functions that are critical to the long-term well-being of humans and our environments, including climate regulation, water filtration and storage, supporting biodiversity, flood and drought regulation, and provisioning of food, fiber, and fuel.
3. Soil health is defined as the capacity of a soil to function within an ecosystem to sustain biological productivity, maintain environmental quality, and promote plant and animal health. Soil can be regarded as a living system, and consists of soil minerals, organic matter, soil organisms, water and gas. The assembly of these materials makes soil a living system. Soil health is analogous to human health in that it defines how well a system can fulfill its different functions. Soil health is measured by quantifying different physical, chemical, and biological parameters.
4. Mulches are known to impact soils in multiple ways, including increasing soil moisture retention by reducing evaporation, modifying soil temperature depending on mulch color, and reducing weed pressure and soil dispersion through splashing. The impacts



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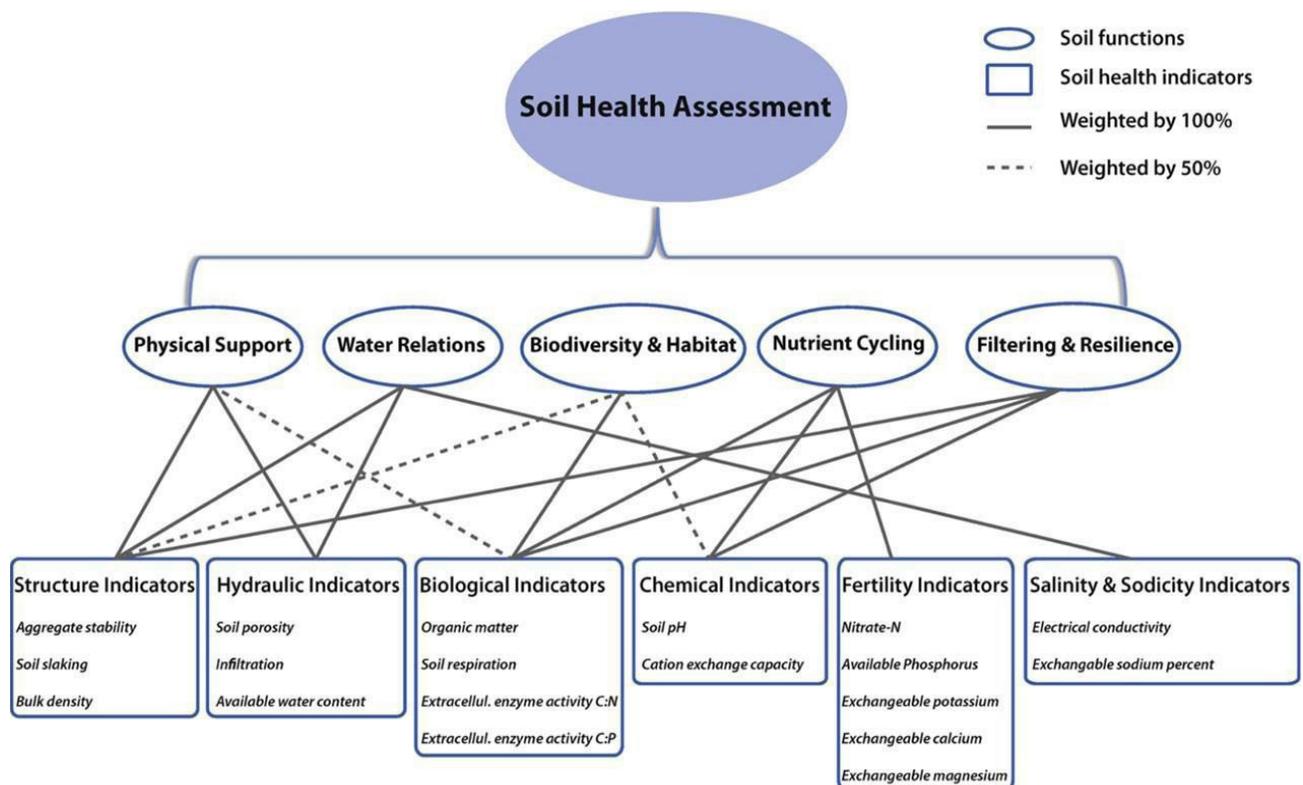
of incorporation of soil-biodegradable mulches on soil health are less well known and the focus of several ongoing projects.

5. One way to determine soil health is to make in-field measurements of various soil health parameters. The USDA has developed a comprehensive soil test kit that can be used in the field. This test kit includes a series of physical, chemical, and biological measurements, some of which are directly made in the field, others in the laboratory. Examples are shown on the previous and the next slide.
6. Soil health is assessed by measuring several soil characteristics, such as soil porosity, soil pH, nitrate concentrations, and organic matter. These parameters are then grouped into hydraulic, biology and fertility indicators. The indicators are then



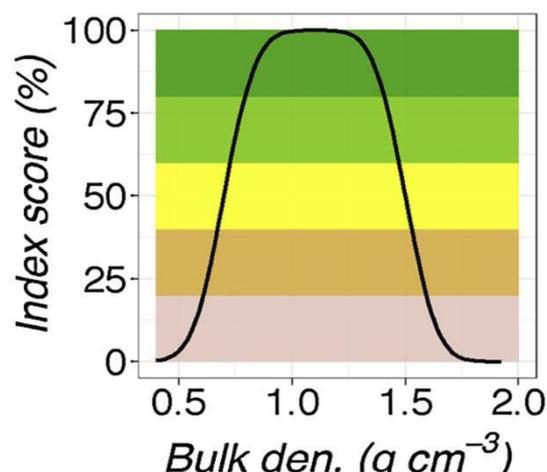
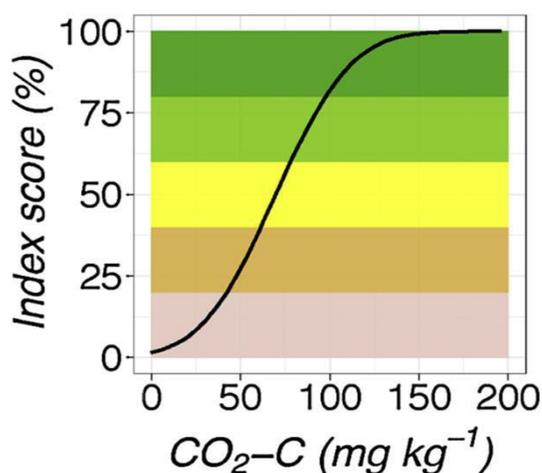
Soil quality test kit guide

combined into soil functions, such as physical support or water relations. This hierarchical structure allows us to aggregate soil health parameters into one unifying concept.



Sintim et al., 2019

7. The way that individual soil health parameters are scored is shown here (Fig. 1). A physical measurement, for instance bulk density, is assigned an index score between 0 and 100%. This assignment is made using a scoring curve that has been developed from nationwide measurements of each parameter. The higher the score, the better the soil health for that parameter. First, we score all soil health parameters with an index between 0 and 100%, then we add them together for a total score.



harvest in fall. Experiments were conducted 2015-2017 at two sites: Knoxville, Tennessee (TN) and Mount Vernon Washington (WA). TN has a warm humid climate, while WA is Mediterranean and mild. This allows us to compare two vastly different climates and soil types. The results showed that site (TN vs WA) and time (spring vs fall) had the greatest impact on soil health variables.

8. We carried out a field experiment 2015-2017 to determine whether repeated use of biodegradable plastic mulch (BDM) has an impact on soil health, either positive or negative. Soil health parameters were measured under 4 different BDM treatments and results were compared against controls of bare soil, paper mulch and conventional polyethylene.

9. The study was set up as a randomized complete block design over a period of 2 and 4 years. The various soil health parameters measured are shown in the slide. Soil health assessment was done twice a year, before planting in spring and after

10. To demonstrate the results of this study, here are the results of the "aggregate stability" soil health parameter (Fig. 2). A higher percent soil aggregate stability is considered more favorable. The data show that, overall, BDMs did not have a negative nor positive impact on soil aggregate stability. The lower-case letters indicate there was no statistical difference among the different mulch treatments. However, there was a difference between the two sites, TN and WA, as is expected because the soil types are different.

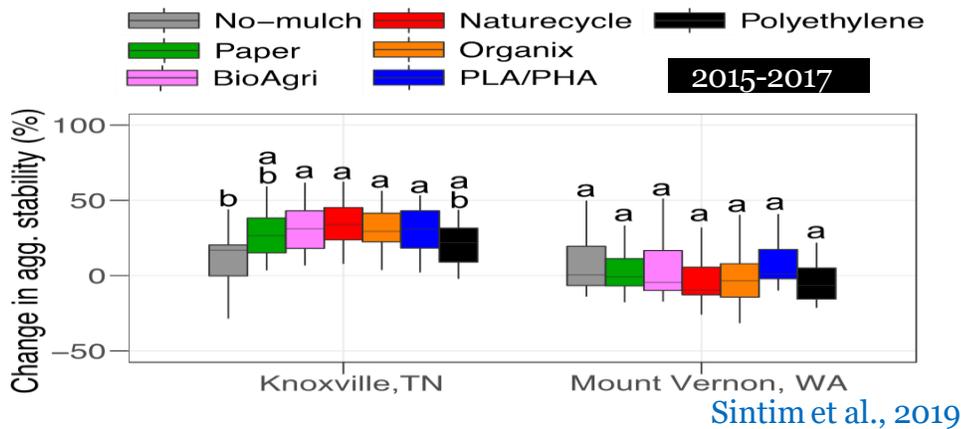
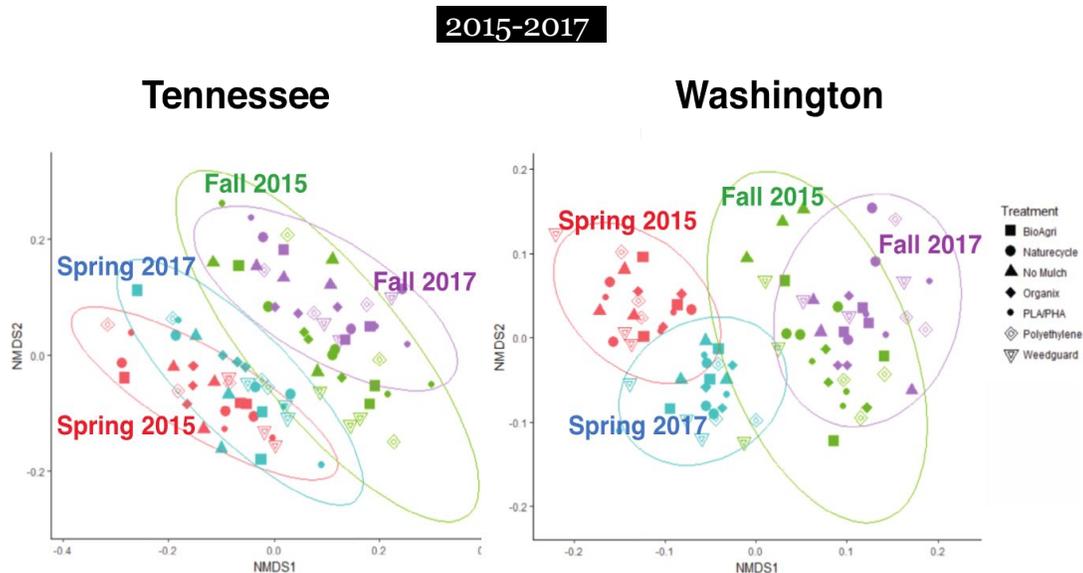


Figure 2. Impact on soil aggregate stability at two different locations (Knoxville, TN and Mount Vernon, WA) due to repeated use of BDM.

11. We determined microbial community structures in the soils at TN and WA (Fig. 3). The data are plotted in the form of a principal component analysis and the different colors represent the different seasons. Each dot represents a microbial community and the closer the dots, the more similar are the microbial communities. The data show that the data points associate most with the different seasons, and less with individual mulch treatments.

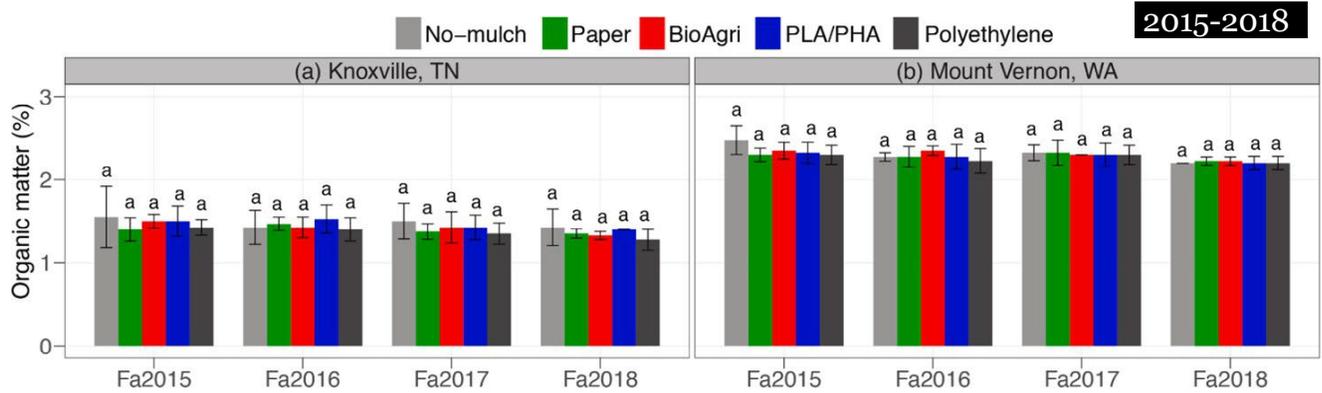
12. Zoomed in scanning electron microscope (SEM) images of mulch films retrieved from the WA field trial show microbial cells living on mulch surfaces, which indicates these surfaces can provide a favorable environment for organisms that may be involved in their degradation.

13. Over 4 years of continuous use of BDM, we did not detect any significant effect on the content of organic matter (Fig. 4). Organic matter was generally higher in WA than in TN, which is expected based on the different climate and soil types in these regions. Nonetheless, in neither state did BDM impact soil organic matter.



Bandopadhyay et al., 2020

Figure 3. Impact on soil microbial communities at two different locations (Tennessee and Mount Vernon).



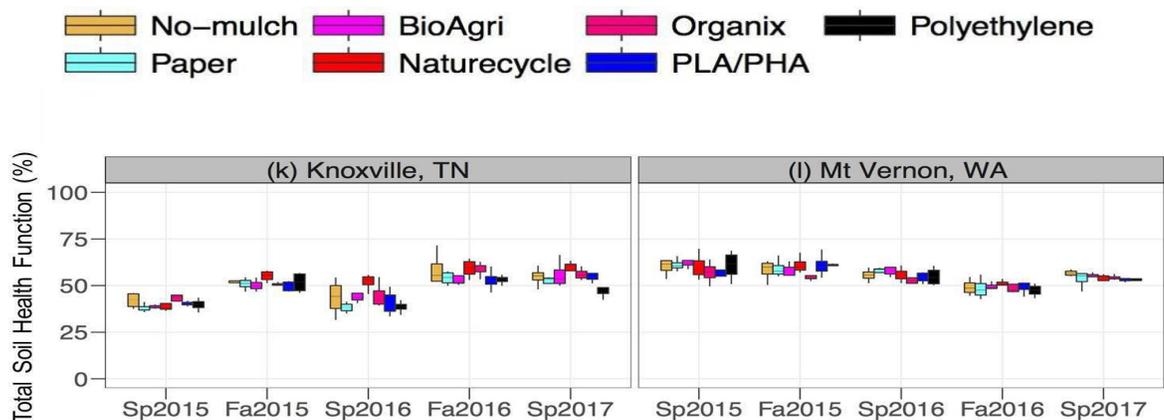
Sintim et al., 2021

Figure 4. Impact on soil organic matter at two different locations (Tennessee and Mount Vernon).

- 14. This slide (Fig. 5) shows the overall soil health, encompassing all measured soil health parameters over 4 years of measurements. The figure shows that the overall soil health fluctuates between spring and fall seasons and there is a difference between TN and WA. Overall, these soil health data indicate no impact of BDM on soil health.
- 15. A new federal grant is funding continuation of previous work, now focusing on strawberry systems. Field trials in WA, CA, FL, and NE are testing the effects of several biodegradable mulch types on soil health parameters and fruit yield. In WA, these

trials overlay with previous trials to look at long-term impacts of biodegradable mulch incorporation on soil health.

- 16. To conclude, use of various BDM products did not negatively impact overall soil health over a period of 2 to 4 years. Soil health parameters varied more among sites (Washington vs Tennessee) and season (spring vs fall). BDM use can help minimize nitrate leaching by promoting plant growth and plant nitrate uptake. Overall, BDM appears to be a viable alternative to PE mulch in terms of soil health. However, evaluation under long-term studies is needed to better establish long-term effects on soil health.



Sintim et al., 2019

Figure 5. Impact on overall soil health at two different locations (Knoxville and Mount Vernon).

## Resources

*These information resources provide background information and additional information to help you have a more thorough understanding of this topic. We encourage presenters to view each one so as to be better prepared for your presentation.*

- Griffin-LaHue, D., S. Ghimire, Y. Yu, E. J. Scheenstra, C. A. Miles, and M. Flury, 2022. In-field degradation of soil-biodegradable plastic mulch films in a Mediterranean climate, *Sci. Total Environ.*, 806, 150238, <https://www.sciencedirect.com/science/article/abs/pii/S0048969721053158?via%3Dihub>
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- Sintim, H. Y., and M. Flury, Is biodegradable plastic mulch the solution to agriculture’s plastic problem? *Environ. Sci. Technol.*, 51, 1068–1069, 2017. (dx.doi.org/10.1021/acs.est.6b06042) <https://www.fao.org/global-soil-partnership/resources/news/presentations-gsb2>



**Plastic Mulches Website**



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