Soil-Biodegradable Mulches: *Workshop*

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Presenter Notes **November 2020**

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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.

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This material is based upon work that is supported by Western Sustainable Agriculture Research and Education, under award number 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.

USDA United States Department of Agriculture National Institute of Food and Agriculture

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

This workshop series provides slide presentations on soil-biodegradable mulches (BDMs). These notes provide additional information for presenters. Numbers in the text correspond to the slides in each 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. 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.
3. 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.

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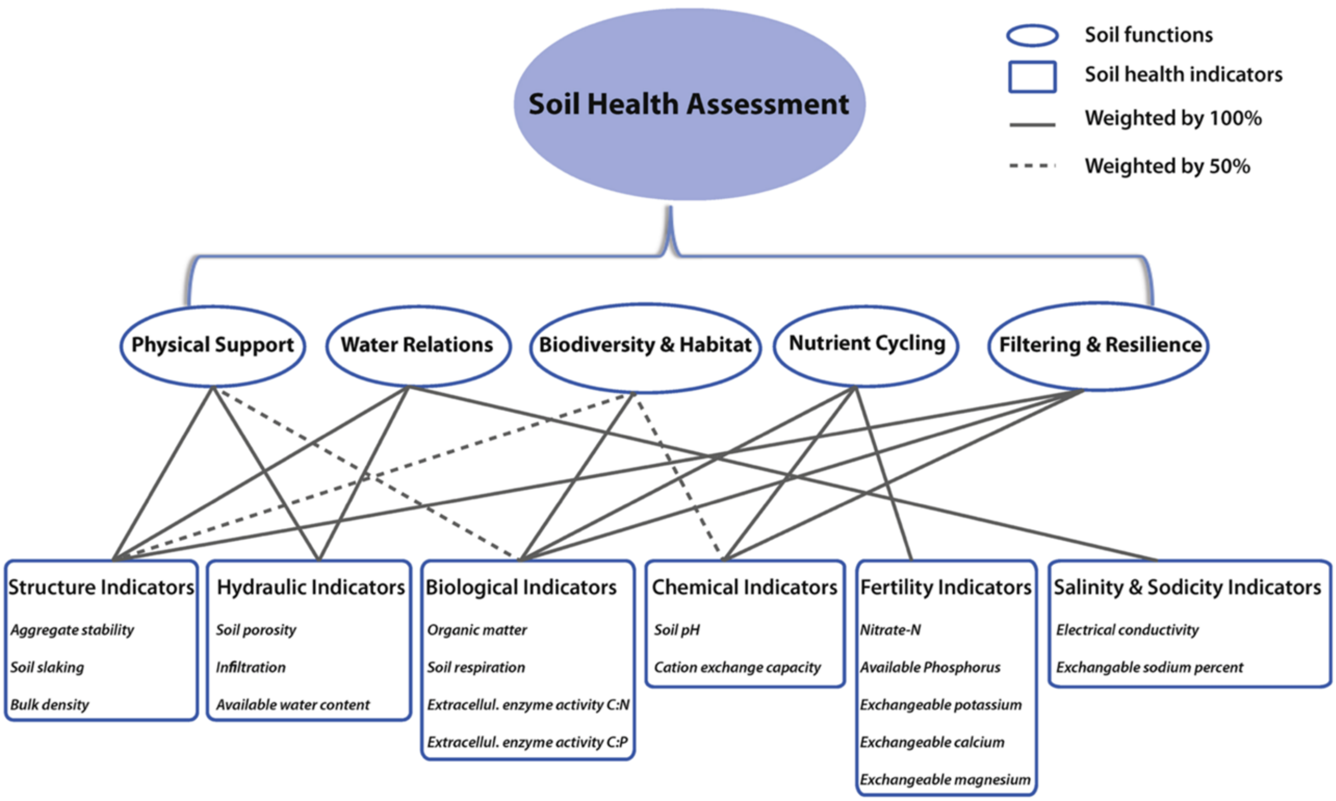
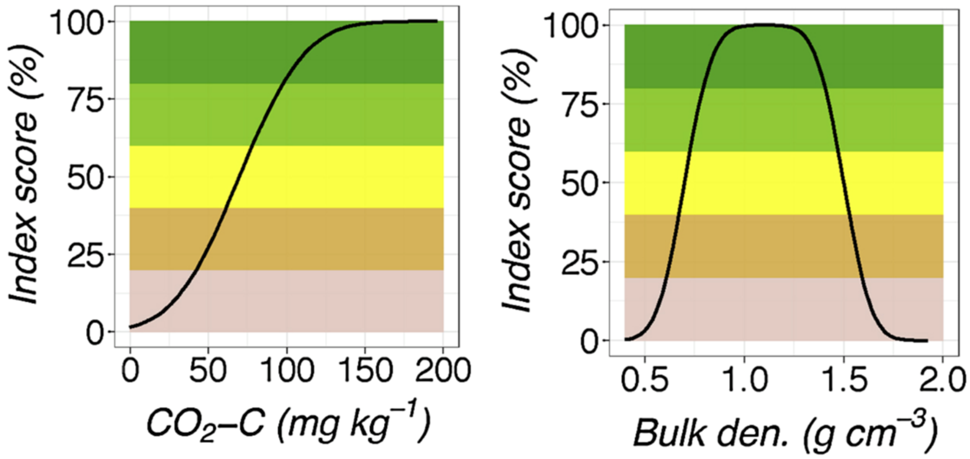
4. Soil health is assessed by measuring several soil characteristics, such as soil porosity, soil pH, nitrate concentrations, and organic matter. These parameters are then grouped into hydraulic, biology and fertility indicators. The indicators are then combined into soil functions, such as physical support or water relations. This hierarchical structure allows us to aggregate soil health parameters into one unifying concept.
5. 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.
6. We carried out a field experiment to determine whether repeated use of biodegradable plastic mulch (BDM) has an impact on soil health, either positive or negative. Soil health parameters were meas-

Soil quality test kit guide



Sintim et al., 2019



Sintim et al., 2019

Figure 1. Index score of soil health parameters.

ured under 4 different BDM treatments and results were compared against controls of bare soil, paper mulch, and conventional polyethylene.

7. The study was setup as a randomized complete bock 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 harvest in fall. Experiments were conducted at two sites: Knoxville, Tennessee and Mount Vernon Washington. 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 greater impact on soil health variables.
8. 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.

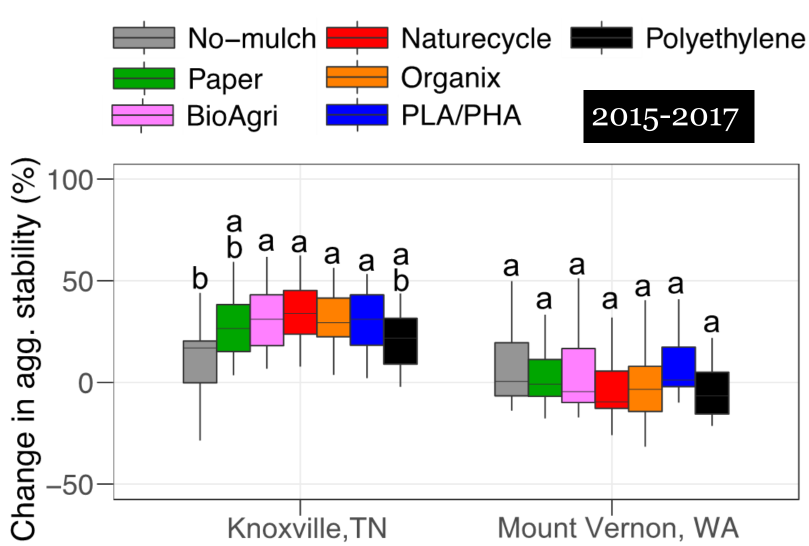
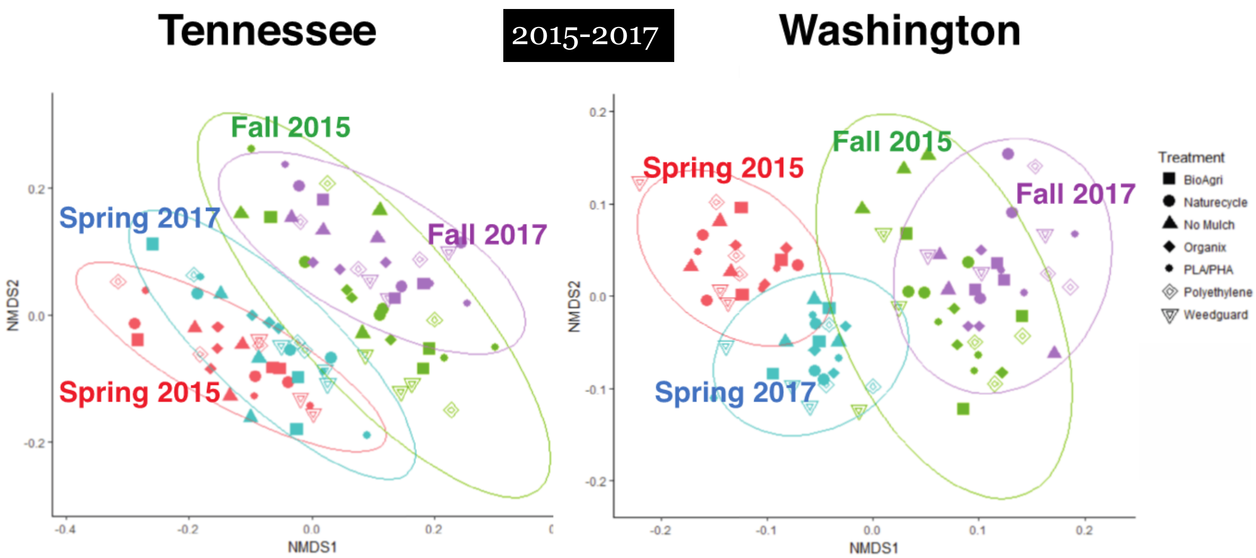


Figure 2. Impact on soil aggregate stability at two different locations (Knoxville, TN and Mount Vernon, WA) due to repeated use of BDM.

Sintim et al., 2019

9. We determined microbial community structures in the soils at TN and WA (Fig. 3). The data are plotted in 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.

10. 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).

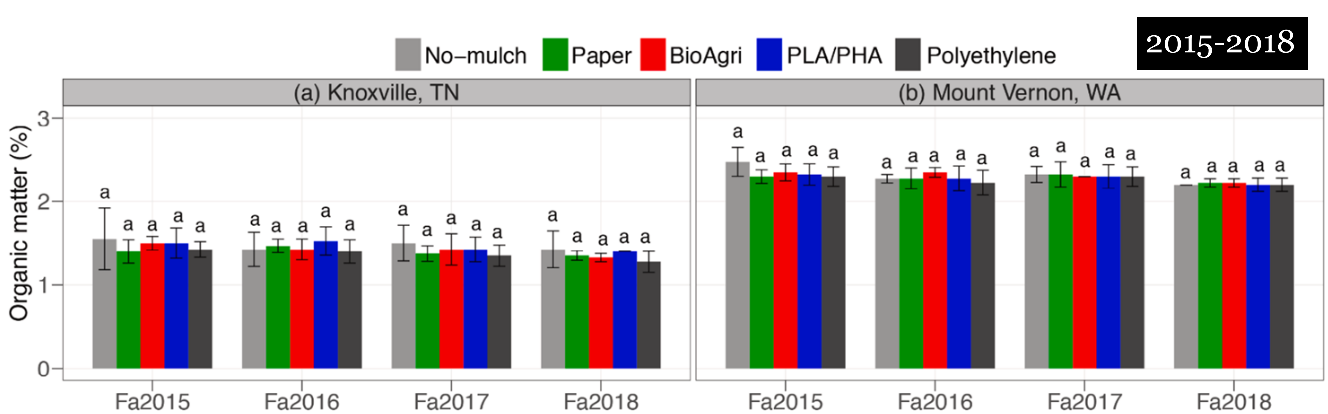
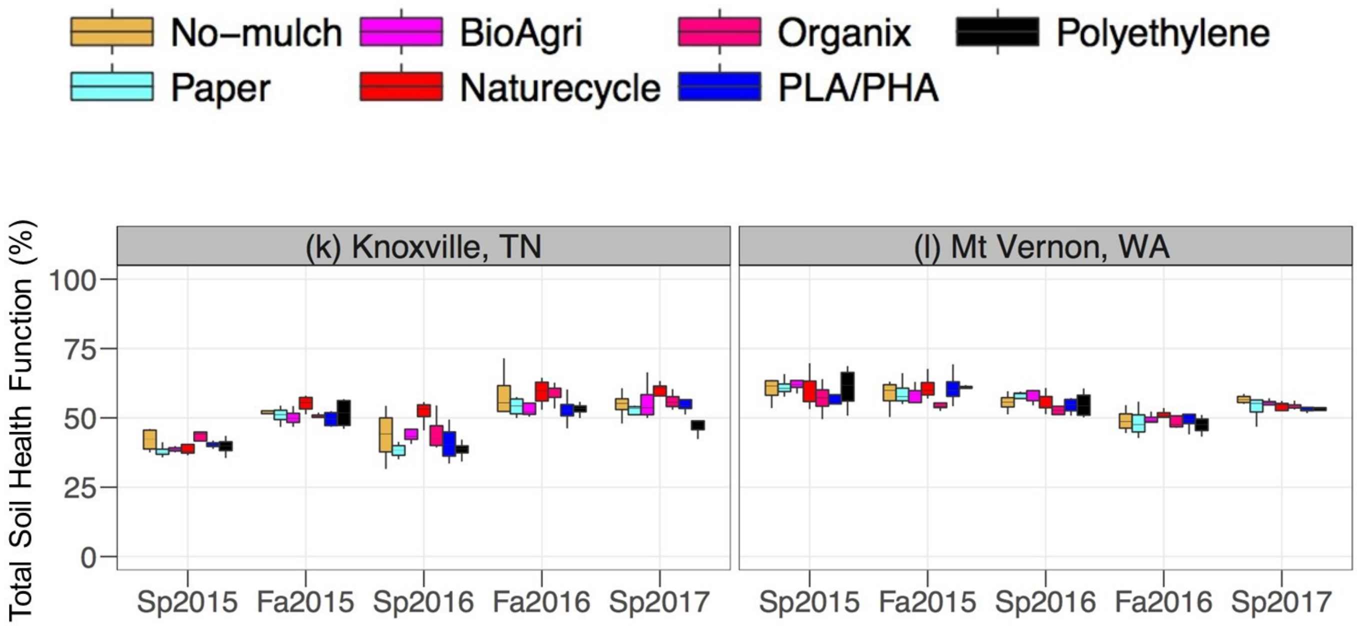


Figure 4. Impact on soil organic matter at two different locations (Tennessee and Mount Vernon).

Sintim et al., 2021

11. 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.
12. 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.

Bandopadhyay, S. H. Y. Sintim, and J. M. DeBruyn, 2020. Effects of biodegradable plastic film mulching on soil microbial communities in two agroecosystems. PeerJ 8:e9015, http://doi.org/10.7717/peerj.9015.

Sintim, H. Y., S. Bandopadhyay, M. E. English, A. I. Bary, J. M. DeBruyn, S. M. Schaeffer, C. A. Miles, J. P. Reganold, and M. Flur. 2019. Impacts of biodegradable plastic mulches on soil health, Agric. Ecosystems Environ., 273:36–49. https://doi.org/10.1016/j.agee.2018.12.002

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