Soil-Biodegradable Mulches: *Workshop*

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Synopsis:
Soil-biodegradable mulches (BDMs) are used in agriculture to replace conventional plastic mulch. This explains the potential changes in expenses while transitioning from PE mulch to BDMs.

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

Economics of Soil-Biodegradable Mulch Use

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 obtained from publications listed in the Reference section.

1. This presentation provides information on the factors to consider in calculating the changes in revenue or expenses while transitioning from polyethylene (PE) mulch to BDMs, and also introduces the Mulch Calculator.
2. Agricultural producers have incentives to adopt new technologies, such as BDMs. Examples of these incentives are improvement of their production efficiency and crop yield, reduction of environmental impact of their production practices, and increase in the profitability of their production activity. In general, the important factors to consider when deciding whether to adopt a new technology are: (1) costs associated with adoption, which include material and labor costs; (2) benefits, such as increased crop yield, and reduced costs in production inputs; and (3) net profit, which is the difference between revenue and costs. Farmers should account for specific benefits and costs associated with technology adoption and compare the net profit relative to that of standard practice. The overall picture is important – which practice generates a higher net profit? If the alternative generates a higher net profit, it means that it is more profitable than the standard practice. Again, it is important to focus on the net profit to stay in business.

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biodegradablemulch.org

3. Farmers need to understand the short-run economic implications of using BDMs. The first question farmers may ask when discussing BDM is, "Do BDMs cost more than PE mulch?". The answer is yes, in general, BDM costs more than PE mulch. In the table presented on this slide (Table 1), cost information is summarized for 4 ft x 4000 ft rolls of PE mulch and plastic BDM, and for 4 ft by 1000 ft rolls of paper BDM. Plastic BDM can be at least twice as expensive as PE mulch, and paper BDM is more expensive than both PE mulch and plastic BDM. The BDM purchase costs given in this table do not include shipping costs. In the following slides, we consider plastic BDM in our analysis which will be referred as simply "BDM" from here on.
4. BDM is generally more expensive than PE mulch and a producer needs to know potential savings associated with BDM use in order to assess if those savings offset the cost of the product. First, account for the material cost of PE mulch. Second, estimate the labor costs for both operator and manual labor for mulch removal, and estimate the amount (weight) of plastic to be removed at the end of the growing season. And third, estimate the labor cost and the disposal cost after removing the PE mulch from the field. Disposal cost includes transportation and landfill disposal fees. Note that disposal costs vary by location, as there are some counties where the only cost associated with disposal is the transportation of PE mulch from the farm to the landfill. In other counties, both transportation costs and disposal fees must be paid. For instance, in Tennessee, disposal fees can be anywhere between $0 and $50 per ton, while in Connecticut, Washington and California, disposal fees could reach $85 to $100 per ton, depending on the county where the landfill is located. Some landfills may not even accept PE mulch for disposal.
5. Finally, a farmer considering using BDM should know that not all end-of-season activities will be eliminated. With PE mulch, drip tape is pulled up together with the mulch. With BDM, on the other hand, there is no mulch to pull up, but drip tape must still be removed before tilling BDM into the soil. Based on one on-farm trial with pepper, removal of drip tape required 1.6 – 2.4 person-hours per acre with 6-feet row spacing. Estimates may vary due to soil, environmental conditions, and other factors. BDM is tilled into the soil as part of field clean-up activities that involves operator labor. Furthermore, tilling BDM may not be an additional cost to the farmer if tillage is one of the typical activities done at the end of the growing season.

Table 1. Size of mulch rolls, purchase costs, and suitability for machine laying.

	Plastic BDMs	PE mulch	Paper BDMs
Roll Dimensions (ft)	4 x 4,000	4 x 4,000	4 x 1,000
Roll thickness (mil)	0.6	1.0	9.0
Purchase cost (without input supplier discount or shipping cost)*	**$204-$245**	**$106-$115**	**$150**
Machine application	Yes	Yes	Yes

6. Now let us go through a hypothetical scenario to illustrate the economic feasibility of using BDM in vegetable production. We are going to focus on changes in expenses and income, and calculate the difference in profit resulting from using BDM instead of PE mulch. In this example, we assume no changes in output price due to the use of BDM, as currently there is no price premium associated with products grown on BDM. We also assume no change in yield due to the use of BDM as many studies show they are similar. On the cost side, BDM is more expensive than PE mulch. BDM is tilled in the soil, but we assume that tillage is a typical end-of-season activity, therefore no additional tillage costs are incurred. There are also potential savings related to the elimination of end-of-season activities, such as PE mulch removal and disposal.
7. To estimate the difference in profits for PE mulch and BDM, we will evaluate the factors affecting the economic feasibility of 1 acre of a vegetable crop grown using a 6 ft space between bed centers:

(a) Two 4 ft x 4000 ft rolls of mulch are needed to cover a 1-acre field.

(b) The cost of 1 4 ft x 4000 ft roll of 1 mil PE mulch is $111 and $220 for 0.6 mil BDM, based on information from various input suppliers.

(c) Labor cost is $14.29/hour based on the New England and New York regions 2020 adverse effect wage rate.

(d) Disposal cost is $85/ton based on information from the Connecticut area.

(e) Based on a survey of Tennessee fruit and vegetable farmers, 17.25 hours/acre are needed for PE mulch removal and disposal.

(f) Based on these assumptions, using BDM instead of PE mulch will have a positive impact on net profits of about $18 per acre.

8. In the next few slides, we will discuss how changes in profits vary when costs for BDM and labor change. In this first figure (Fig. 1), we have cost of BDM on the horizontal axis. On the vertical axis, we have the difference in the profit of using two different mulch types. Therefore, when the difference is positive, it means that using BDM is more profitable than using PE mulch. In this graph, we only vary the price of a BDM roll, while revenue and all other production costs are the same.
9. Now, let us evaluate potential changes in profits given different number of labor hours per acre for removal and disposal of PE mulch. Note that we only vary labor hours, while all other variables are the same. In this graph (Fig. 2), when labor hours associated with PE mulch removal and disposal increase, the labor cost savings become

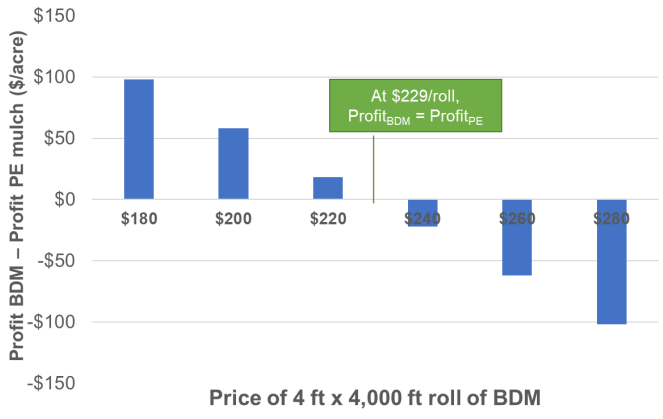

Figure 1. Sensitivity analysis of profit due to change in BDM cost.

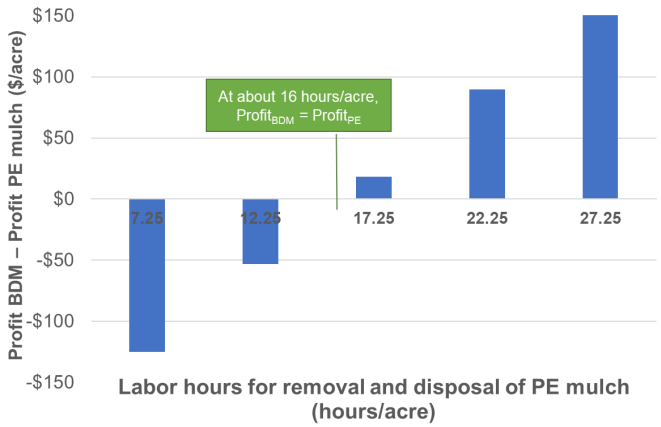

Figure 2. Sensitivity analysis of profit due to change in labor hours for removal and disposal of PE mulch.

higher when using BDM because these activities are eliminated. Therefore, such scenario translates to BDM use being more profitable. For example, if 22.25 labor hours per acre are needed for PE mulch removal and disposal, the profit associated with using BDM are higher than that of PE mulch by about $90/acre. On the other hand, if 12.25 labor hours per acre are required, the profit is lower than that of PE mulch by about $53 per acre. The difference in profit is zero ($Profit_{BDM}$ = $Profit_{PE\ mulch}$) at 16 hours per acre.

10. What if the required labor hours are the same but we vary the labor rates? Individual states have different labor rates. Recall that for our illustration, we used the labor rate in New England and New York, which is $14.29/hour. This map (Fig. 3) shows that the adverse effect wage rate as of 2020 ranges between $11/hour to $16/hour–the lowest in seven southern states and the highest in Oregon and Washington.
11. The next slide shows the sensitivity of the difference in profits between the alternative mulch types given different labor rates, while holding all other variables the same. In the horizontal axis, from left to right we show the minimum, average, median and maximum labor rates (Fig. 4). There is no difference in profits when labor rate is $13.14/hour. This means that when the hourly labor rate is above $13.14, it is more profitable to use BDM. This scenario highlights the potential benefits to growers of using BDM, as alternative to PE mulch, when the prevailing wage rates in their area for agricultural workers are high.
12. We would like to make some important notes about labor.

- In small operations, the farm owner is often responsible for performing cleanup activities at the end of the season. These hours are often not considered a direct cash expense and may be overlooked when estimating total labor costs. Calculating the value of this unpaid labor will help assess the monetary value of the end-of-season activities and will also help plan for future scenarios where owners may not be physically able to do this job and may have to hire workers.
- For farms employing migrant workers, although labor savings are important, it is also important to know the implications of reducing end-of-season activities or letting workers leave the farm early. If their labor hours are reduced, workers may decide to go to another farm that will employ them for more hours per season. Therefore, it is essential for the farmer to be aware of the unintended conse-

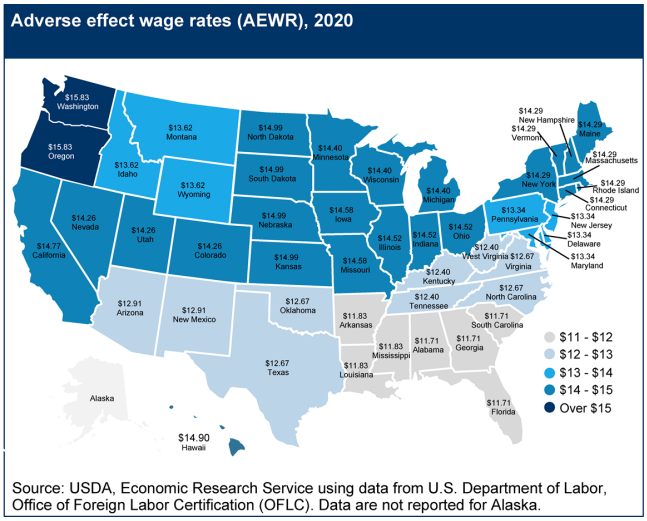

Figure 3. Adverse effect wage rates in the United States.

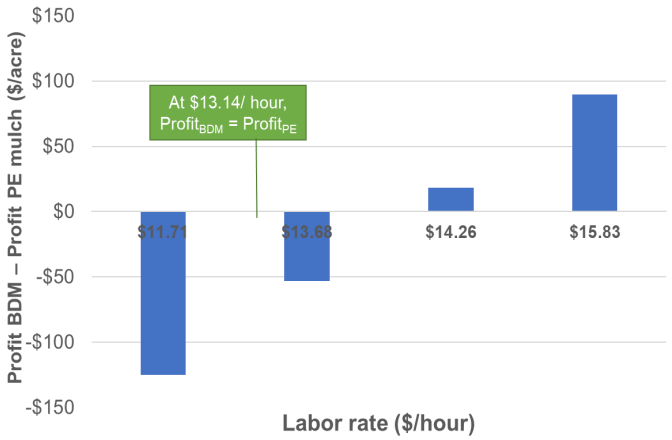

Figure 4. Sensitivity analysis of profit due to change in labor rate for removal and disposal of PE mulch.

quences of reducing workers' hours at the end of the season.

13. What are the resources available for agricultural producers and other stakeholders to estimate and compare the costs of using alternative mulches? Our research team developed an interactive "Mulch Calculator" that assists farmers to determine the quantity of much needed and provides cost comparison of BDM to PE mulch. It is available for free. The two components are a Requirement Calculator which calculates the number of rolls of mulch (per acre or per hectare) to be purchased based on roll length and spacing between bed centers, and a Cost Calculator which includes machinery cost, material cost, as well as the cost of labor to install the mulch and costs associated with cleanup activities.
14. Several assumptions are made in using the mulch calculator. Required machinery and number of person-hours to install PE mulch and BDM are assumed to be the same. In the Cost Calculator example, PE mulch removal is by hand; machinery cost would need to be added. Drip tape is removed simultaneously with PE mulch and 1.5 hours per acre is assumed to calculate the cost of removing drip tape before BDM is tilled into the soil (this number can be adjusted as needed). PE mulch is disposed in a landfill for fee, while BDMs are tilled into the soil thereby eliminating removal and disposal costs. It usually takes 3 hours per acre to till BDM into soil based on field study in WA, but largely depends on type of equipment used (this number can be modified if needed and may be zero if tillage is already a typical field activity at the end of the growing season). Other resources will be provided at the end of this presentation.
15. What are the main points that we hope you will take away from this presentation?

- Since BDM is more expensive, in general, than PE mulch, should the grower still consider using BDM? The answer is yes, considering some important factors.
  - ◊ The clear benefits of using BDM are in terms of the elimination of end-of-season activities associated with PE mulch, particularly removal and disposal costs.
  - ◊ The use of BDM is potentially a more profitable alternative than PE mulch given one or a combination of the following: low to moderate material cost of BDM, high labor requirement to remove and dispose PE mulch, and high farm labor rates.
- In assessing whether the use of BDMs is economically feasible for a farm, there are three critical factors: (1) the costs, (2) benefits, and (3) net profit; all compared to what can be realized in the standard practice. The third factor is the most important, overall. If growers focus only on costs, they will be unable to take advantage of opportunities or benefits that can improve their net profit, and will likely have an unsustainable business model. Although farmers are concerned about costs relatively, it is net profit (Revenue – Costs) that keeps them in business.

16. This last slide presents several resources that are publicly available for your information — the Mulch Calculator, three publications about the economic feasibility of BDM, dimensions, costs and other important considerations for using BDM, and a couple of other useful websites.

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.

Basic information sources, frequently asked questions, videos, and publications — BDM project website:
https://www.biodegradablemulch.org

Dimensions and Costs of Biodegradable Plastic and Polyethylene Mulches (raspberry emphasis)
https://s3.wp.wsu.edu/uploads/sites/2181/2017/06/FactSheet.CostandDimensions-2.pdf

Important Considerations for the Use of BDM in Crop Production
https://research.libraries.wsu.edu/xmlui/handle/2376/13104

Information and materials for use of mulches in small fruit production
https://smallfruits.wsu.edu/plastic-mulches/

Mulch Calculator
https://ag.tennessee.edu/biodegradablemulch/Documents/Chen-Mulch-calculcator-introduction.pdf

The Economics of Adopting Biodegradable Plastic Mulch Films
https://ag.tennessee.edu/biodegradablemulch/Documents/Velandia%20et%20al%20The%20Economics%20of%20Adopting%20Biodegradable%20Mulch.pdf

The Economic Feasibility of Adopting Plastic Biodegradable Mulches in Pumpkin Production
https://extension.tennessee.edu/publications/Documents/W822.pdf
https://pubs.extension.wsu.edu/economic-feasibility-of-using-alternative-plastic-mulches-a-pumpkin-case-study-in-western-washington