National Organic Standards Board
Crops Subcommittee
Petitioned Material Proposal
Biodegradable Mulch Film Made from Bioplastics

August 15, 2012

Introduction

A petition was submitted requesting the addition of biodegradable biobased bioplastic mulch to section 205.601(h) of the National List. This petition involves definitions of new substances, which the subcommittee recommends be incorporated into the listing. The subcommittee explicitly seeks public comment on the definitions and possible restrictions on use.

Background

Biodegradable mulch film made from bioplastics is petitioned to section 205.601 of the National List for use in organic crop production. This is an alternative to petroleum-based plastic mulches that do not completely biodegrade. Over the past 50 years much research and development has gone into developing biodegradable mulches which are the subject of this petition. As product development has been underway, removal and disposal of polyethylene plastic mulches has become increasingly difficult because its removal is time-consuming, delays cover cropping and must largely be sent to landfills. The OFPA requires the removal of plastic mulches at the end of the growing or harvest season (7 U.S.C. 6508).

The petitioner argues that OFPA's mention of plastic was not intended to refer to biodegradable mulch film. Biodegradable mulch is intended to biodegrade by the end of the season or prior to the beginning of the following season. This distinction leads us to question whether the approval of the petition would require a rule change to allow the mulch to biodegrade in the field or whether the two substances should be treated as separate and distinct. However, bioplastics are defined in terms of "plastics," according to the petitioner, "Biodegradable Plastic Mulch is defined as plastic mulching material that meets both of the following requirements." Furthermore, bioplastics fit the definition of plastic, "Any of various organic compounds produced by polymerization, capable of being molded, extruded, cast into various shapes and films, or drawn into filaments used as textile fibers." (*American Heritage Dictionary*) The petition defines biodegradable mulch film as mulching materials that:

1) meet the requirements of ASTM International (formerly American Society for Texting and Materials) Standard D6400 or D6868 specifications, or of other international standard specifications with essentially identical criteria, i.e. EN 13432, EN 14995, ISO 17088; and

2) show at least 90% biodegradation absolute or relative to microcrystalline cellulose2 in less than two years, in soil, tested according to ISO 17556 or ASTM 5988.

Additionally, the petitioner suggests that the reference to "fully biodegradable" in section 205.206(c)(1) be defined when referencing bioplastic degradation in soil. Full biodegradation is covered under several standards which discuss the compostability of the petitioned product. These include, American Society for Testing and Materials (ASTM) Standard D5988 (biodegradability of bioplastic in soil), ASTM Standard D6400 (biodegradability of bioplastic in compost), and ASTM Standard D6868 (biodegradability of bioplastic specifications). The

ASTM definition of “biodegradable plastic” is, “a degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae.”

The petition further clarifies, that according to the European Bioplastics’ definition, bioplastics are biobased, biodegradable, or both. The ASTM definition of “biobased material” is “organic material in which carbon is derived from a renewable resource via biological processes. Biobased materials include all plant and animal mass derived from carbon dioxide recently fixed via photosynthesis, per definition of a renewable resource.” Biobased materials are certified using the ASTM D6866 method, which certifies the biologically derived content of bioplastics.

The petition provides the following description: biodegradable films are produced from bioplastics that meet standards for aerobic biodegradation in soil. These bioplastics are comprised of structural units which may be easily broken down into carbon substrates by soil microorganisms. Under aerobic conditions, these microorganisms are able to utilize the carbon substrates as a food source. This metabolism of the carbon substrates ultimately results in two simple compounds – carbon dioxide and water.

Relevant areas in the Rule

OFPA §6508 (c) says

> For a farm to be certified under this chapter, producers on such farm shall not -
> …(2) use plastic mulches, unless such mulches are removed at the end of each growing or harvest season;

The regulations provide at §205.206(c) that

> Weed problems may be controlled through:
> … (6) Plastic or other synthetic mulches: *Provided,* That, they are removed from the field at the end of the growing or harvest season.

And the National List includes at §205.601(b)(2)

> Mulches.
> …(ii) Plastic mulch and covers (petroleum-based other than polyvinyl chloride (PVC)).

Discussion

Neither conventional plastic mulch nor biodegradable bioplastic mulch can perform all of the functions—particularly, feeding the soil—that organic mulches perform. However, there are times—such as when cold soil is a problem—when the qualities of plastic or bioplastic have been viewed as necessary. As always, it is our understanding that the use of synthetic mulch products will be limited to those circumstances when natural organic mulches are inappropriate or impossible to use. When this is the case, it makes sense to use a material that degrades in place rather than one that is removed and taken to a landfill. On the other hand, the subcommittee believes that it may be difficult to separate claims from truth concerning biodegradability and the source of the material. In addition, the subcommittee would like to make a robust recommendation that correctly describes biodegradable biobased bioplastic mulches that meet the three criteria above. According to the European Bioplastics definition, bioplastics are biobased, biodegradable, or both. The committee intends this recommendation to cover those bioplastics that are both biobased and biodegradable.

The subcommittee understands the importance of a definition, which it is proposing, and is particularly interested in public comment on the biobased classification and the ASTM standard. Meeting this standard, however, does not automatically ensure that the mulch will be "removed from the field at the end of each growing or harvest season." This removal may require steps like tilling the film into the ground. The subcommittee therefore proposes the annotation that growers take appropriate actions to guarantee that the mulch decomposes within the appropriate time frame.

Evaluation Criteria

(Applicability noted for each category; Documentation attached)	**Criteria Satisfied? (see "B" below)**		
1. Impact on Humans and Environment	☒ Yes	☐ No	☐ N/A
2. Essential & Availability Criteria	☒ Yes	☐ No	☐ N/A
3. Compatibility & Consistency	☒ Yes	☐ No	☐ N/A
4. Commercial Supply is Fragile or Potentially Unavailable as Organic (only for § 205.606)	☐ Yes	☐ No	☒ N/A

Substance Fails Criteria Category: [ ] **Comments:**

Proposed Annotation:
List on §205.601(b)(2) Mulches: (iii) Biodegradable biobased bioplastic mulch meeting the following criteria: (A) Completely biodegradable as shown by: 1) meeting the requirements of ASTM Standard D6400 or D6868 specifications, or of other international standard specifications with essentially identical criteria, i.e. EN 13432, EN 14995, ISO 17088; and 2) showing at least 90% biodegradation absolute or relative to microcrystalline cellulose in less than two years, in soil, tested according to ISO 17556 or ASTM 5988; (B) Biobased certified using the ASTM D6866 method; (C) Must be produced without excluded methods; (D) Must be produced without engineered nanomaterials; and (E) Grower must take appropriate actions to ensure complete degradation at the end of each growing or harvest season.

Basis for annotation: ☒ To meet criteria above ☒ Other regulatory criteria ☐ Citation
Notes: Annotation is necessary to meet the requirements of OFPA §6508(c).

Recommended Subcommittee Action & Vote, including classification recommendation (state actual motion):

Classification Motion:
Biodegradable Mulch Film Made from Bioplastics is synthetic.

Motion by: Colehour Bondera Seconded by: Jay Feldman
Yes__**8**___ No__**0**__ Abstain__0__ Recuse__0__ Absent__**0**__

Listing Motion:
To list on §205.601(b)(2) Mulches: (iii) Biodegradable biobased bioplastic mulch meeting the following criteria: (A) Completely biodegradable as shown by: 1) meeting the requirements of ASTM Standard D6400 or D6868 specifications, or of other international standard specifications with essentially identical criteria, i.e. EN 13432, EN 14995, ISO 17088; and 2) showing at least 90% biodegradation absolute or relative to microcrystalline

cellulose in less than two years, in soil, tested according to ISO 17556 or ASTM 5988; (B) Biobased certified using the ASTM D6866 method; (C) Must be produced without excluded methods; (D) Must be produced without engineered nanomaterials; and (E) Grower must take appropriate actions to ensure complete degradation at the end of each growing or harvest season.

Motion by: Colehour Bondera Seconded by: Barry Flamm
Yes__**7**___ No__**0**__ Abstain__**1**__ Recuse__**0**__ Absent__**0**__

Crops	☒	**Agricultural**	☐	**Allowed**[1]	☐
Livestock	☐	**Non-synthetic**	☐	**Prohibited**[2]	☐
Handling	☐	**Synthetic**	☒	**Rejected**[3]	☐
No restriction	☐	**Commercial unavailable as organic**	☐	**Deferred**[4]	☐

[1]Substance voted to be added as "allowed" on National List to § 20 with Annotation (if any):

[2]Substance to be added as "prohibited" on National List to § 205 with Annotation (if any):

Describe why a prohibited substance:

[3]Substance was rejected by vote for amending National List to § 205. Describe why material was rejected:

[4]Substance was recommended to be deferred because

If follow-up needed, who will follow up:

Approved by Subcommittee Chair to Transmit to NOSB

Jay Feldman, Subcommittee Chair August 15, 2012

NOSB Evaluation Criteria for Substances Added To the National List

Category 1. Adverse impacts on humans or the environment? Substance: Biodegradable Mulch Film Made from Bioplastics

Question	Yes	No	N/A[1]	Documentation (TAP; petition; regulatory agency; other)
1. Are there adverse effects on environment from manufacture, use, or disposal? [§205.600 b.2]		x		TER 525-531: The production of PLA & PHA involves fermentation processes & feedstocks derived from natural sources (with the exception of genetically-modified organisms). The potential for environmental

				contamination from these products is limited, with the exception of the metal salt catalysts used to polymerize PLA (Bastioli, 2005). No reports of tin contamination from production of bioplastics were found.
2. Is there environmental contamination during manufacture, use, misuse, or disposal? [§6518 m.3]		x		TER 533-537: Many of the feedstocks used in the production of AAC could be hazardous if they were spilled or discharged into the environment during manufacture & processing. No specific reports of environmental contamination from these compounds as a result of manufacturing bioplastics were found. Systematic reviews of the environmental impact from manufacturing of bioplastics were not found. TER 547-550: Erucamide, glycerol, & searic acid amide could be released to the environment through multiple manufacturing processes, including bioplastics production. No research reports were found that described environmental releases of these chemicals from bioplastics manufacturing.
3. Is the substance harmful to the environment and biodiversity? [§6517c(1)(A)(i);6517(c)(2)(A)i]		x		TER 614-621: The researchers concluded that using PE mulch may have a harmful effect on the environment due to increased runoff & is less sustainable than vegetative mulch (Rice et al., 2001). Based on their similarities in construction & intended use, bioplastic mulches would likely have similar environmental impacts to PE mulch, though their greater tendency to degrade sooner than PE mulch may decrease some of the adverse environmental impacts. TER 623-627: Anaerobic degradation of bioplastics may produce methane (greenhouse gas). Research was not found that quantified methane emissions from bioplastic mulch use. Degradation of bioplastic mulches must take place in an aerobic environment in the soil to prevent methane emissions. TER

				629-630: Adverse environmental impacts from the use of bioplastic mulches are only likely to occur if the material does not completely biodegrade in soil. TER 652-657: Some reports have shown that bioplastics containing terephthalic acid at concentrations over 50% do not completely biodegrade in soil (Bastioli, 2005).
4. Does the substance contain List 1, 2 or 3 inerts? [§6517 c (1)(B)(ii); 205.601(m)2]			x	
5. Is there potential for detrimental chemical interaction with other materials used? [§6518 m.1]		x		TER 566-567: The plastics are inert in the soil when they are intact, and are biodegraded by soil microorganisms.
6. Are there adverse biological and chemical interactions in agro-ecosystem? [§6518 m.5]		x		TER 582-587: Given the complete aerobic biodegradation of bioplastic mulches, the by-products are carbon dioxide, water, & soil biomass. Soil biomass refers to the total amount of microorganisms in the soil, excluding plant roots & macrofauna (NRCS, 2012). The increase in biomass may cause a concomitant increase in the populations of microorganisms that degrade the mulches on a local basis. This could lead to changes in the population dynamics of microorganisms in the soil. TER 593-595: Complete degradation of the bioplastics depends on blending the polymers to maximize degradability & depends on the composition of soil microorganisms.
7. Are there detrimental physiological effects on soil organisms, crops, or livestock? [§6518 m.5]		x		TER 352-354 ASTM standard D5988 is designed to be applicable to bioplastic materials that are “not inhibitory to the bacteria & fungi present in the soil”…it could be assumed that the bioplastic does not inhibit soil bacteria or fungi by its breakdown processes. TER 357-358: Many bacteria & fungi in the soil can use bioplastics derived from starch as a carbon source (Shah et al., 2008). TER 409-410: Biochar, a method of generating carbon black for soil

				amendment, may help promote nutrient use efficiency in treated soils (Chan, 2008; Hunt, 2010).
8. Is there a toxic or other adverse action of the material or its breakdown products? [§6518 m.2]		x		TER 446-447: Studies were not found that specifically assessed the ecotoxicity of bioplastics following degradation in the soil, & a better understanding of bioplastic degradation & soil environmental effects is needed. TER 462-466: It seems unlikely that the source material (the bioplastic film) would interact with other organisms & cause toxicity. The material is manufactured to remain intact & inert during its intended use, then (ideally) break down at the end of the season.
9. Is there undesirable persistence or concentration of the material or breakdown products in environment? [§6518 m.2]	x	x		TER 330-333: The petitioner states that biodegradable mulch film is defined in two ways…Second, by "show[ing] at least 90% biodegradation absolute or relative to microcrystalline cellulose in less than two years, in soil, tested according to ISO 17556 or ASTM 5988." TER 347-350: ISO 17556 & ASTM 5988 are equivalent standards. They "describe the standard test method for determining aerobic biodegradation of plastic materials in soil." This standard is most applicable to the proposed use of the bioplastic mulch because the mulches will be left in the field at the end of the season to biodegrade according to their petitioned use. TER 356-357: Biodegradability is quantified by measuring the amount of carbon dioxide released from the soil over time. TER 362-370: degradation occurs quicker when chiseled or tilled into the soil during times of warm temperatures & moisture in soils with high organic matter. TER 374-375: Hydrolysis breaks PLA into lactic acid & water-soluble compounds. Once this breakdown occurs, PLA is completely mineralized to CO2, water, & biomass. TER 384-386:

				Degradation of PHA occurs by enzymatic hydrolysis at the surface of the film, which is carried out by soil microbial populations. Hydrolysis breaks the PHA polymers into oligomers & monomers which are subsequently consumed & assimilated by microbes in the soil as nutrients. TER 395-399: All of the commercially available AAC polymer materials contain terephthalic acid, which is most responsible for determining the degradation rates in AAC plastics. As the fraction of terephthalic acid increases, the degradation rate decreases. No significant biological degradation was found when the molar fraction of AAC was increased to more than 60%, which is thought to be due to the relatively low melting point of terephthalic acid (Bastioli, 2005). TER 405-410: Carbon black is elemental carbon in the form of a particulate that is manufactured from burning or partial combustion of hydrocarbons (NLM, 2011)…it is resistant to breakdown in the soil environment. TER 412-419: Titanium dioxide is found as the minerals rutile, octahedrite, brookite, ilmenite, & perovskite. Titanium dioxide may persist in soil as the by-product of titanium tetrachloride hydrolysis (ATSDR, 1997), so it may persist from use in bioplastic mulch as well. Titanium dioxide may settle out into sediments & persist for long periods of time (ATSDR, 1997). The compound is characterized by ATSDR as " a very inert compound" (ATSDR, 1997). TER 421-425: Erucamide (plasticizer) binds strongly to soil & sediments in water & is likely to bioconcentrate in aquatic organisms, meaning it will occur at higher levels up the food chain (NLM, 2011). The physical properties of erucamide suggest that the material

				will persist in the environment, and would be found in the water, soil & air if released (NLM, 2011). TER 427-431: Glycerol (plasticizer) released to the environment will be present as both a vapor & a particle in the atmosphere, but will be degraded within hours (NLM, 2011). The potential for bioconcentration in aquatic organisms is low for glycerol in aquatic environments (NLM, 2011).
10. Are there any harmful effects on human health? [§6517 c (1)(A)(i); 6517 c(2)(A)i; §6518 m.4]		x		TER 663-673: Pesticide runoff may be increased if plastic mulches are used in agricultural production due to the creation of impervious surfaces (Rice et al., 2001). The increase in pesticide loads may lead to an overall increase in the pesticide load in waterways which could potentially impact human health by causing increases in pesticide loads in downstream drinking water sources. No other reports of impacts on human health from the use of bioplastic mulches were found in the published literature.
11. Is there an adverse effect on human health as defined by applicable Federal regulations? [205.600 b.3]			x	
12. Is the substance GRAS when used according to FDA's good manufacturing practices? [§205.600 b.5]			x	
13. Does the substance contain residues of heavy metals or other contaminants in excess of FDA tolerances? [§205.600 b.5]			x	

[1]If the substance under review is for crops or livestock production, all of the questions from 205.600 (b) are N/A—not applicable.

NOSB Evaluation Criteria for Substances Added To the National List

Category 2. Is the Substance Essential for Organic Production? Substance:

Question	Yes	No	N/A[1]	Documentation (TAP; petition; regulatory agency; other)
1. Is the substance formulated or manufactured by a chemical process? [6502 (21)]	x			TER 294-296: Bioplastic mulches are manufactured with the addition of synthetic plasticizers and colorants which are added using a synthetic process.
2. Is the substance formulated or manufactured by a process that chemically changes a substance extracted from naturally occurring plant, animal, or mineral, sources? [6502 (21)]	x			TER 301-302: To develop PLA the lactic acid monomers must be polymerized. This is accomplished through the use of a chemical catalyst. TER 302-305: Fermentation is a naturally occurring process, but under laboratory conditions, the feedstocks and environmental conditions are manipulated in order to provide an environment that is most conducive to production of PLA, a process which would be unlikely to occur in nature. TER 309-310: Researchers have developed genetically-engineered bacterial strains that produce PHA more efficiently & in differing polymer amounts. TER 313-315: PHA production by fermentation is a natural process, but the conditions used in laboratories to maximize yields and polymer amounts are not naturally occurring. TER 317-319: Some feedstocks used to produce AAC are naturally occurring, but the chemical processes used to refine them for use do not occur in nature, nor do the synthetic processes that are used to create the ester linkages.
3. Is the substance created by naturally occurring biological processes? [6502 (21)]	x	x		
4. Is there a natural source of the substance? [§205.600 b.1]			x	
5. Is there an organic substitute? [§205.600 b.1]			x	
6. Is the substance essential for			x	

handling of organically produced agricultural products? [§205.600 b.6]				
7. Is there a wholly natural substitute product? [§6517 c (1)(A)(ii)]	x			TER 679-682: The petitioned substance would be an alternative to synthetic, non-degradable substance, polyethylene plastic mulch. Bioplastic mulch is produced through synthetic processes as previously described, but is created to be biodegradable, a reason for its petitioned use in organic agriculture. TER 684-690: Mulches made from biomass include bark, cocoa-bean hulls, corncobs, grass clippings, leaves, pine needles, sawdust, straw, & wood chips. Biomass mulch availability may depend on what types of plants or crops are available in the area & the type of crop they are used in.
8. Is the substance used in handling, not synthetic, but not organically produced? [§6517 c (1)(B)(iii)]			x	
9. Is there any alternative substances? [§6518 m.6]	x			TER 717-721: Living mulch involves planting a low-growing cover crop that is effective at competing with weed species. The drawback is that living mulches compete for nutrients & water & reduce yields. Reports discuss the need to strike a balance between environmental impact, cost, ease of use, & crop yields to determine which alternative is most beneficial for individual farms & crops.
10. Is there another practice that would make the substance unnecessary? [§6518 m.6]		x		

[1]If the substance under review is for crops or livestock production, all of the questions from 205.600 (b) are N/A—not applicable.

NOSB Evaluation Criteria for Substances Added To the National List

Category 3. Is the substance compatible with organic production practices?
Substance:

Question	Yes	No	N/A[1]	Documentation (TAP; petition; regulatory agency; other)
1. Is the substance compatible with organic handling? [§205.600 b.2]			x	
2. Is the substance consistent with organic farming and handling? [§6517 c (1)(A)(iii); 6517 c (2)(A)(ii)]	x	x		The substance is of synthetic origin but appears to completely biodegrade in a two-year timeframe. This serves as an alternative to the current practice of using synthetic, non-degradable, polyethylene plastic mulch.
3. Is the substance compatible with a system of sustainable agriculture? [§6518 m.7]	x			
4. Is the nutritional quality of the food maintained with the substance? [§205.600 b.3]			x	
5. Is the primary use as a preservative? [§205.600 b.4]			x	
6. Is the primary use to recreate or improve flavors, colors, textures, or nutritive values lost in processing (except when required by law, e.g., vitamin D in milk)? [205.600 b.4]			x	
7. Is the substance used in production, and does it contain an active synthetic ingredient in the following categories: a. copper and sulfur compounds;		x		
b. toxins derived from bacteria;		x		
c. pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals?		x		
d. livestock parasiticides and medicines?		x		
e. production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleaners?		x		TER 218- 221: Bioplastic mulch is used as a production aid, but is not technically considered a row cover because they increase soil temperature, reduce weed pressure, maintain soil moisture levels, and may

				help extend the growing season.

[1]If the substance under review is for crops or livestock production, all of the questions from 205.600 (b) are N/A—not applicable.

NOSB Evaluation Criteria for Substances Added To the National List

Category 4. Is the commercial supply of an agricultural substance as organic, fragile or potentially unavailable? [§6610, 6518, 6519, 205.2, 205.105 (d), 205.600 (c) 205.2, 205.105 (d), 205.600 (c)] **Substance: Name**

Question	Yes	No	N/A[1]	Documentation (TAP; petition; regulatory agency; other)
1. Is the comparative description provided as to why the non-organic form of the material /substance is necessary for use in organic handling?			x	
2. Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **form** to fulfill an essential function in a system of organic handling?			x	
3. Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **quality** to fulfill an essential function in a system of organic handling?			x	
4. Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **quantity** to fulfill an essential function in a system of organic handling?			x	
5. Does the industry information provided on material / substance non-availability as organic, include (but not limited to) the following: a. Regions of production (including factors such as climate and number of regions);			x	
b. Number of suppliers and amount produced;			x	

c. Current and historical supplies related to weather events such as hurricanes, floods, and droughts that may temporarily halt production or destroy crops or supplies;			x	
d. Trade-related issues such as evidence of hoarding, war, trade barriers, or civil unrest that may temporarily restrict supplies; or			x	
e. Are there other issues which may present a challenge to a consistent supply?			x	

[1]If the substance under review is for crops or livestock production, all of the questions from 205.600 (b) are N/A—not applicable.