Soil-biodegradable mulches

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February 2021

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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, and was adapted from SCRI 2014-51181-22382. 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

Glossary of terms associated with soil-biodegradable mulches for specialty crops

1. Additive: A substance added to something in small quantities typically to improve or preserve it. [1]
2. Adoption: The "decision to make full use of an innovation as the best course of action available." The decision to adopt or reject an innovation is the "decision" stage of the "innovation-decision process," which is the "process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to the formation of an attitude toward the innovation, to a decision to adopt or reject, to implementation and the use of a new idea, and to confirmative of this decision." [24]
3. ASTM: Also known as American Society for Testing and Materials, ASTM is an international standards organization that develops and delivers voluntary consensus standards for a wide range of materials, products, systems, and services. [4]
4. Benefit-cost analysis: The application of discounted cash-flow analysis to measure the benefits and costs generated by an investment. [68]
5. Biobased: Commercial or industrial products (other than food or feed) that are composed in whole or in significant part of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials. [86]
6. Biobased Plastics: High polymeric materials obtained through chemical or biological synthesis from raw materials. Some share of the carbon atoms in biobased plastics are derived from renewable *feedstocks* (a term defined below)

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and some fossil-fuel-based carbon. The percentage of *biobased* ingredients and the conditions under which the biobased product may biodegrade, if at all, vary widely. (compare to *bioplastic,* below) [80]

7. Biodegradable: Capable of being broken down by the action of naturally occurring microorganisms such as bacteria, fungi, and algae. Complete biodegradation (i.e., mineralization) refers to the oxidation of the parent compound (an organic molecule) to CO_2 and water. [47]
8. Biodegradable mulch (other): Whole plant, plant debris, or plant product such as cover crops, straw, tree bark, wood chips, or paper, that is used for weed control and moisture conservation. Often tends to reduce soil temperatures. Will biodegrade in the soil due to microbial activity. Biodegradable plastics can also be used to create a biodegradable mulch, but the extent and rate of biodegradation is subject to environmental conditions and mulch material properties. See "biodegradable plastic mulch". [7] [51]
9. Biodegradable plastic: Degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae. [76]
10. Biodegradable plastic mulch: Manufactured alternative to nondegradable plastic mulch. Ideally, biodegradable mulch provides the same benefits as plastic mulch (weed control, soil temperature moderation, reduced soil-borne pathogens, soil moisture retention, and soil conservation) and provides the added benefit of being 100% biodegradable, either in field soil or a composting environment, with no formation of toxic residues. [41]
11. Biodegradability Standardized Test, Ambient Soil Conditions (ASTM D5988-3): Standard test method for determining aerobic biodegradation in soil of plastic materials or residual plastic materials after composting. [12]

    Requires the following:

    - Soil samples from diverse location as a matrix and source of inoculum
    - Operated via a desiccator.
    - Biodegradation assessed by comparison to a positive control.
    - CO2 measured via reaction with Ba(OH)2, yielding BaCO3; reactant Ba(OH)2 concentration determined via titration.
    - Biodegradation can also be monitored through BOD (biological oxygen demand). [77]
12. Biodegradability Standardized Test, Industrial Composting Conditions (ASTM D5338-98) [12]: Standard test method for determining aerobic biodegradation of plastic materials under controlled composting conditions that are similar to D5988, except:
    - A specified compositing apparatus is required.
    - 2-L reactors with aerators.
    - A robust means of measuring CO2, such as IR, should be considered.
    - Positive and negative controls are used. [78]
13. Biofumigation: Elimination or suppression of plant pathogens, nematodes or weeds in the soil by amendment with biological products, often Brassica plants or seed meals or Allium (onion) plant products. Brassica species produce isothiocyanates as they break down, and appear to directly suppress some pests. They may also act indirectly on the pests by favoring the growth of organisms antagonistic to pathogens. [43]
14. Biomass: The total mass of all organisms in a given population or geographical area; usually expressed as total dry weight. Biological material derived from living, or recently living organisms. In the context of biomass for energy, this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material. [87]

15. Bioplastics: They are not just one single substance but consist of a whole family of materials with differing properties and applications. According to European Bioplastics, a plastic material is defined as a bioplastic if it is either bio-based, biodegradable, or features both properties. (See also *biobased plastic*) [80]
16. Biopolymer: A polymeric substance (as a protein or polysaccharide) formed in a biological system. [19]
17. Breaking force: The ability of a material to withstand a pulling or tensile force. Used as a mechanical test to measure and compare the strength of a film or other materials. [11]
18. Carbon Black (dyeing agent): Any of the various colloidal black substances consisting wholly or principally of carbon obtained usually as soot and used especially in tires and as pigments. Also used to color mulch. [10]
19. Carbon pool: Amount of organic and inorganic carbon in a controlled volume of soil. [89]
20. Cellulose: A polysaccharide consisting of a linear chain of glucose molecules linked by β-1,4-glycosidic bonds which is the most important structural component in plants. [14] [15]
21. CEN: European Committee for Standardization (CEN), a public standards organization whose mission is to foster the economy of the European Union (EU) in global trading, the welfare of European citizens and the environment by providing an efficient infrastructure to interested parties for the development, maintenance and distribution of coherent sets of standards and specifications. [23]
22. Certification: The provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements. [16]
23. Clean technology: A means of rendering goods or services that exhibit similar or better level of functionality, measurably superior environmental performance, at comparable long-run economic costs as that of those goods/services rendered by conventional technology. [18]
24. Compostability Standard, Industrial Composting Conditions (ASTM D6400): Standard specification for compostable plastics:
    - For "…plastics that are designed to be composted in municipal and industrial aerobic composting facilities"
    - Establishes "the requirements for labeling …as "compostable in municipal and industrial composting facilities"
    - Degradable plastic: "…designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard test methods"
    - Biodegradable plastic: "a degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae."
    - Requirement 1: Loss of 90% dry mass of plastic under composting during 12 weeks (ASTM D5338 [11] standardized biodegradability test) [19]
    - Requirement 2: ("inherent biodegradation") 60% of C atoms converted to CO2 in 180 days (compared to control) for single polymers (for blends, 60 or 90% conversion in 12 weeks, depending on the nature of the blend). [75]
25. Compostable plastic: A plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials, and leaves no visible, distinguishable, or toxic residue. [76]
26. Composting (agricultural sense): The process 'to compost' is the biological decomposition of organic materials by microorganisms under controlled, aerobic conditions to produce a relatively stable humus-like material called 'compost'. For agricultural operations the common materials or feedstocks that are composted are livestock manures, livestock bedding, and various residual

plant materials (straw, culls, on-farm processing wastes, etc.). Composting is much more than just allowing manure to pile up and decompose until ready for use—it is a science. The decomposition occurs in a well-managed process to obtain specific positive results–a valuable product–with a minimum of negative environmental impacts. [38]

27. Composting (materials sense): A managed process that controls the biological decomposition and transformation of biodegradable materials into a humus-like substance called compost: the aerobic mesophilic and thermophilic degradation of organic matter to make compost; the transformation of biologically decomposable material through a controlled process of bio-oxidation that proceed through mesophilic and thermophilic phases and results in the production of CO_2, water, minerals, and stabilized organic matter. (compost or humus). [76]
28. Crop covers: Also called row covers. Flexible, transparent or semi-transparent materials used to cover and protect crops from cold, wind, and insect damage. Two main types of material commercially used are polyethylene (clear) and porous, floating, nonwoven polyester or polypropylene. Examples of trademark manufacturers include Reemay, DuPont, Kenbar, Polymax, Starfoam. [37]
29. Cover crop: A densely planted, natural or introduced crop grown primarily to improve and maintain soil structure, add organic matter, and prevent soil erosion. [70]
30. Decomposition: The process by which dead organic substances are broken down into simpler organic or inorganic matter such as CO_2, water, simple sugars and mineral salts. [20]
31. Degradable plastic: Plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard test methods. [76]
32. Degradable polymeric material (or "plastic"): a polymeric material designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard test methods appropriate to the polymeric material and the application in a period of time that determines its classification. [76]
33. Degradation: A deleterious change in the chemical structure, physical properties, or appearance of a plastic. [40]
34. Deterioration: Loss of physical or mechanical strength, as observed through physical strength testing, microscopic imaging, or sizable macroscopic alteration of morphology (e.g. rips, tears, and holes assessed visually). Different than '*degradation*' – see definition above. [35]
35. Earthworm standardized test: Experimental quantification of the number of earthworms per soil surface area. Earthworms are extracted by a solution of mustard, which acts as an irritant. [89]
36. Ecotoxicity: Within the field of ecotoxicology, ecotoxicity refers to the potential for biological, chemical and/or physical stressors to affect ecosystems. It also refers to the potential or real adverse effects that a chemical can cause to an aquatic or terrestrial organism. [3]
37. End products: Final output of an activity, arrangement, or process. Articles, materials, and supplies delivered (or are to be delivered) under a contract. [12]
38. Enterprise Budget: A budget estimation for a crop or livestock production activity; listing the production goal, management activities, resource requirements, and economic returns. An enterprise budget contains the following elements or sections:
    - production goal,
    - expected market price and gross receipts,
    - planned management activities with required resource inputs and costs, and
    - estimated net return and break-even price (BEP) for the goal production. [65]

39. Environmental burden: The total set of resources used, emissions and residues during the life cycle of a product or an item. Total impact on the environment of a construction product or project. [50]
40. Extrusion: A process by which a heated polymer is forced through an orifice to form a molten stream that is cooled to form a filament or fiber. A solution of the polymer can also be forced through the orifice into a solvent that causes the fiber to solidify. [13]
41. Extruder: An apparatus for extrusion. [13]
42. Fabric: A sheet structure made from fibers, filaments or yarns. [13]
43. Feedstock: Raw material to supply or fuel a machine or industrial process. [25]
44. Fermentation: A biologically driven chemical process by which molecules, such as glucose, are broken down to produce energy in the absence of oxygen. [26]
45. Fumigant: Vapor-active (volatile) pesticide or material used to kill disease-causing organisms, insects, nematodes, weeds, and other pests; a gaseous or readily volatilizable disinfectant or disinfectant used to destroy organisms by vapor action in an enclosed area or under plastic laid on the soil. Fumigants may be volatile liquids and solids as well as substances already gaseous.[70]
46. Genetically Modified Organisms (GMOs): An organism whose genome has been altered through genetic engineering to favor the expression of desired physiological traits or the output of desired biological products. [8]
47. Glass transition temperature: The temperature range where a polymer substrate changes from a rigid, glassy material to a soft (not melted) material, and is usually measured in terms of the stiffness, or modulus. [28]
48. Green chemistry: Green chemistry, also known as sustainable chemistry, is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use. [5]
49. Impact: The social, economic, civic, and/or environmental consequences of an educational program. Impacts tend to be longer-term and so may be equated with goals. Impacts may be positive, negative, and/or neutral and intended or unintended. [81]
50. Innovation: An idea, practice, or object that is perceived as new by an individual or other unit of adoption. It matters little, so far as human behavior is concerned, whether or not an idea is 'objectively' new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If an idea seems new to the individual, it is an innovation. [24]
51. Interdisciplinary Research: Any study or group of studies undertaken by scholars from two or more distinct scientific disciplines. The research is based upon a conceptual model that links or integrates theoretical frameworks from those disciplines, uses study design and methodology that is not limited to any one field, and requires the use of perspectives and skills of the involved disciplines throughout multiple phases of the research process. (compare to *transdisciplinary research*, below) [32]
52. ISO: Also known as the International Organization for Standardization, it is an independent, non-governmental international organization that develops voluntary, consensus-based, market relevant international standards. [39]
53. Label: A slip of paper, cloth, or other material, marked or inscribed, for attachment to something to indicate its manufacturer, nature, ownership, destination, etc. [44]
54. Landscape fabric: A textile material used to control weeds by inhibiting their exposure to sunlight. The fabric is normally placed around desirable plants, covering areas where other growth is

unwanted. The fabric itself can be made from synthetic or organic materials, sometimes from recycled sources. [45]

55. Leaching (carbon leaching): Transfer of material (carbon) through action of water movement out of a controlled volume of soil. [46]
56. Life cycle assessment: The method/process for evaluating the effects that a product has on the environment over the entire period of its life from 'cradle to grave', thereby increasing resource use efficiency and decreasing liabilities. [67]
57. Lysimeter: An instrument to collect water percolating (leaching) through the soil. [46]
58. Lysimetry: The method associated with using a lysimeter. [46]
59. Meltblown: A nonwoven web forming process that extrudes and draws molten polymer resins with heated, high velocity air to form fine filaments. The filaments are cooled and collected as a web onto a moving screen. [13]
60. Mechanical strength: The ability of a material to stand up to mechanical forces being applied without it bending, breaking, shattering, or deforming. [63]
61. Mesophilic: A mesophile is an organism that grows best in moderate temperatures, neither too hot nor too cold, with an optimum growth range from 20 to 45 °C . An organism that displays this characteristic is called "mesophilic". [62]
62. Mineralization: Microbial conversion of organic matter into inorganic substances, such as water and CO2. [30]
63. Mulch: (verb) Application of a covering (bulk, film or fabric) to the soil surface of a row of plants. (noun) Any product so applied. Common mulches include straw, sawdust and polyethylene film. Mulches are most commonly used to control weeds, but can also modify soil temperature and can reduce water loss due to evaporation from the soil surface. Film mulches are commonly used in solarization, fumigation and biofumigation. [51]
64. Mulch density: The mass per unit volume of mulch. [21]
65. Nonwoven fabric: A fabric made directly from a web of fiber, without the yarn preparation necessary for weaving and knitting. In a nonwoven, the assembly of textile fibers is held together 1) by mechanical interlocking in a random web or mat; 2) by fusing of the fibers, as in the case of thermoplastic fibers; or 3) by bonding with a cementing medium such as starch, casein, rubber latex, a cellulose derivative or synthetic resin. Initially, the fibers may be oriented in one direction or may be deposited in a random manner. This web or sheet is then bonded together by one of the methods described above. Fiber lengths can range from 0.25 inch to 6 inches for crimped fibers up to continuous filament in spunbonded fabrics. Nonwoven fabrics are currently used as weed mats, and row covers. [13]
66. Organic agriculture: According to the USDA National Organic Standards Board (NOSB), organic agriculture is defined as "an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off -farm inputs and on management practices that restore, maintain, or enhance ecological harmony. [34]
67. Organic Materials Review Institute (OMRI): Provides third party, independent review of products intended for use in certified organic production, handling, and processing. Also provides technical support and training for professionals in the organic industry. A 501(c)3 nonprofit organization founded in 1997. When companies apply, OMRI reviews their products against the organic standards. Acceptable products are OMRI Listed® and appear on the *OMRI Products List*© or *OMRI Canada Products List*©. [52]
68. Organic standards: A federal program managed by USDA, the National Organic Program (NOP) has standards which producers must meet in order to be certified as organic. Standards include inputs and techniques that are allowable and not allowable. An overview of being certified organ-

ic includes: avoidance of prohibited synthetic chemical inputs (e.g. fertilizers, pesticides, antibiotics, food additives, etc.), genetically modified organisms, irradiation, and the use of sewage sludge; use of farmland that has been free from prohibited chemicals for three or more years; keeping detailed written production and sales records (audit trail); maintaining strict physical separation of organic products from non- certified products; and undergoing periodic on-site inspections. [2]

69. Outcomes: Results or changes that occur from an educational effort. Outcomes may relate to changes in knowledge, awareness, skills, attitudes, opinions, aspirations, motivation, behavior, practice, decision-making, policies, social action, condition or status. Outcomes may be intended and unintended; positive and negative. Outcomes fall along a continuum from immediate (initial; short-term) to intermediate (medium-term) to final outcomes (long-term), often synonymous with impacts. [81]
70. Oxo-degradable plastic: Oxo-degradable plastics are made of petroleum-based polymers and supplemented with specific additives, like metal salts of carboxylic acids and dithiocarbamates, that cause them to degrade. These additives only facilitate fragmentation of the materials, which do not fully degrade but break down into very small fragments that remain in the environment. [48] [53]
71. Paper mulch: Products vary from 32-40-pound kraft paper, may be dyed black, unbleached, or undyed 100% recycled kraft paper. Papers may be treated with natural substances such as vegetable oil (soybean) and elemental sulfur. The product comes on rolls, generally 36 – 48 inches wide and up to 1500 feet long. Primarily used for weed control, soil moisture conservation, and soil erosion control. Tends to reduce soil temperature and is short lasting (3-4 months). Offers many of the advantages of plastic mulches, but does not require disposal as it is biodegradable and can be tilled into the soil after harvest. Trade name products include 'Planters Paper' and 'Weed Guard'. [50]
72. Passive solar: Using sunlight for useful energy without use of active mechanical systems. Such technologies convert sunlight into usable heat (water, air, thermal mass), cause air-movement for ventilating, or store heat for future use, with little use of other energy sources. Passive solar systems have little to no operating costs, often have low maintenance costs, and emit no greenhouse gases in operation. [54]
73. PBAT: Also known as polybutyrate, it is a semi-aromatic, biodegradable thermoplastic copolyester that can be easily molded and thermoformed. It is produced by random co-polymerization of 1,4-butanediol, adipic acid, and dimethyl terephthalate (DMT) monomers. Its properties are typically similar to those of high- or low-density polyethylene but is completely biodegradable. [57]
74. Percent soil exposure (PSE): The percentage of exposed bed or row area (soil) after mulch application due to abiotic or biotic factors. A measure of deterioration. [27]
75. Permeability: The ability to be penetrated or passed through, especially by a liquid or gas. [55]
76. PET: Polyethylene terephthalate (sometimes written poly(ethylene terephthalate)), is a thermoplastic polymer resin of the polyester family and is used in synthetic fibers; beverage, food and other liquid containers; thermoforming applications; and engineering resins often in combination with glass fiber. It is one of the most important raw materials used in man-made fibers. [59]
77. Photo-degradable plastic: A polymer that is disintegrated through exposure to sunlight. [56]
78. Plastic film: A thin sheet of plastic material, sometimes transparent, used to wrap or cover things. [64]
79. Plastic mulch: A thin plastic sheet usually 0.6 – 1.5 mm in thickness, available as 36 – 90 inch wide rolls, up to 6000 feet long and used to cover the soil in a bed or row primarily for weed control. Often used in conjunction with drip irrigation and crops grow through slits or holes in the plastic sheet. Impacts soil temperatures and conserves moisture from irrigation; available in vari-

ous colors and weights. Disposal of the plastic mulch after use is an issue in most areas where it is used.[50]

80. Polyhydroxyalkanoate (PHA): Fatty acid biopolymers that are biosynthesized by microbial polyhydroxyalkanoate synthase enzymes. They are being investigated for use as biodegradable polyesters. [9]
81. Polylactic acid (PLA): A type of plastic, specifically a thermoplastic polyester. PLA is a more general classification that includes PLLA [poly(L-lactic acid)] , PDLA [poly(D-lactic acid)] , and PDLLA [poly(D,L-lactic acid) where polymers contain mixtures of D- and L- monomeric units). The differentiation is related to chiral carbon that occurs in lactic acid monomeric unit (its "building block" consists of OOC-CH(OH)CH3). Lactic acid produced by most organisms is primarily in the L-enantiomeric form. PLA is used in building models and prototypes of solid objects and components (such as in 3-D printing) and as an additive in manufacturing processes and applications. [58]
82. Polymer: A substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins. [60]
83. Polymerization: The process in which relatively small molecules, called monomers, combine chemically to produce a very large chainlike or network molecule, called a polymer. [61]
84. Radiocarbon analysis (13C, 14C): Quantitative analysis of the amounts of 13C or 14C in sample. The amount of 13C or 14C is usually expressed in relation to the amount of 12C. [17]
85. Recyclate: The raw material that is sent to and processed in a waste recycling plant or materials recovery facility which will be used to form new products. [82]
86. Recycling: A resource recovery method involving the collection and treatment of waste products for use as raw material in the manufacture of same or similar product. Similarly, upcycling is the process of transforming by-products, waste materials, useless, or unwanted products into new materials or products perceived to be of greater quality, such as artistic value or environmental value. [82]
87. Renewable materials: Renewable raw materials comprise the totality of plant, animal and/or microbial biomass, including biomass delivered through food chains, whose primary production is based on photosynthesis and which are provided for material and energy uses of all kinds outside food and feed. With material use, the biomass serves as raw material for the (industrial) production of all types of goods. [22]
88. Renewable resources: Resources capable of being continuously renewed or replaced through such processes as organic reproduction and cultivation such as those practiced in agriculture, animal husbandry, forestry and fisheries. [22]
89. Risk: The quantifiable uncertainty that could lead to changes in an individual's welfare such as losing money, potential harm to human health, and events that affect availability of resources, among others. In general, agriculture risk typically is correlated with the chance of a negative outcome (e.g., financial loss or yield decrease) and the uncertainty in the decision-making process due to incomplete information such as market prices. [31]
90. Risk Management: The evaluation of risk sources together with the identification of strategies to avoid or minimize their impact; the systematic application of management policies, procedures and practices to the tasks of identifying, analyzing, assessing, treating and monitoring risk. [31] [33]
91. Soil carbon: Sum of organic and inorganic carbon in soil. [89]
92. Soil ecology: Soil ecology is the study of how soil organisms interact with other organisms and their environment – their influence on and response to numerous soil processes and properties form the basis for delivering essential ecosystem services. [71]

93. Soil Fumigation – The application of a fumigant, generally applied to soil under plastic, for the purpose of disinfesting the area. [modified from 70]
94. Soil health: The capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health is called soil health. Soil health and soil quality may be used interchangeably. [72]
95. Soil organic carbon: Sum of all organic forms of carbon in the soil. [89]
96. Soil quality: The capacity of a soil to function. Soil quality can be assessed by measuring a set of soil properties to evaluate the soil's ability to perform basic functions (i.e., maintaining productivity, regulating and partitioning of water and solute flow, filtering and buffering against pollutants, and storing and cycling nutrients). Often used interchangeably with "soil health". [89]
97. Soil quality test kit: A packaged system with materials that can be used to measure physical, biological, and chemical soil quality indicators. The USDA has developed a comprehensive soil test kit that can be used in the field along with a guide that describes procedures and interpretations. Physical properties addressed by the kit include bulk density, water content, infiltration rate, aggregate stability, slaking, and morphological estimations. Biological properties measured include soil respiration and earthworms. Soil chemical properties measured include pH, electrical conductivity (EC), and soil nitrate levels. [73]
98. Soil respiration: Respiration by organisms in the soil. Soil respiration is an indicator of biological activity (i.e., microbial and root), or soil life. This activity is as important to the soil ecosystem as healthy lungs are to us. [89]
99. Solarization: Elimination or suppression of plant pathogens, nematodes or weeds in the soil by solar heating. The soil is brought up to a moist, workable condition (typically about 70% of field capacity) and is worked to a fine texture. Clear film is laid tightly over the soil and remains in place for several weeks to several months. The practice is most effective under hot, sunny conditions. [42]
100. Specialty crops: Fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops including floriculture. [85]
101. Spunbond(ed): The filaments have been extruded, drawn and laid on a moving screen to form a web. The term is often interchanged with "spunlaid," but the industry conventionally adopted the spunbond or spunbonded term to denote a specific web forming process. This is to differentiate this web forming process from the other two forms of the spunlaid web forming, which are melt blown and flashspinning. [13]
102. Standards: Standards are the written and enforced rules of a society. Standards set thresholds that must be met by a product or practice in order to be approved by a given organization. ASTM D6400 is one of the most cited standards for BDMs that assesses compostability. EN 17033 is the first standard issued by an international organization that pertains directly to biodegradation of plastics (particularly BDMs) in soil. [36]
103. Standardized tests: Standardized tests determine whether the thresholds for a standard are met. ASTM D6400 employs a standardized test method, ASTM D5338, which utilizes a laboratory test that simulates industrial composting conditions (i.e., the use of a compost-based medium, 58 °C , etc.) to determine the degree and rate of aerobic biodegradation of plastic materials. [36]
104. Starch: Starch or amylum is a polymeric carbohydrate consisting of numerous glucose units joined by glycosidic bonds. This polysaccharide is produced by most green plants for energy storage. [74]
105. Supply chain: A network of organizations involved in the supply and distribution of products, services, finances, and/or information from a source to a final user (e.g., consumer). Entire network of entities, directly or indirectly interlinked and interdependent in serving the same consumer or customer; including vendors that supply raw material, producers who convert the ma-

terial into products, warehouses that store, distribution centers that deliver to the retailers, and retailers who bring the product to the ultimate user. [49] [79]

106. Sustainable agriculture: An integrated system of plant and animal production practices having a site-specific application that will over the long-term satisfy human food and fiber needs, enhance environmental quality and the natural resource base upon which the agriculture economy depends, make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls, sustain the economic viability of farm operations, and enhance the quality of life for farmers and society as a whole. [84]

107. Sustainable development: To meet the needs of the present without compromising the ability of future generations to meet their own needs. [88]

108. Sustainable material: Materials from renewable sources that can be produced at high volumes without adversely affecting the environment or critical ecologies. [75]

109. Synthetic material: (As per U.S. Organic Agriculture certification) "a substance that is formulated or manufactured by a chemical process or by a process that chemically changes a substance extracted from a naturally occurring plant, animal, or mineral sources, except that such term shall not apply to substances created by naturally occurring biological processes." [2]

110. Thermophilic: A thermophile is an organism that has optimum growth temperatures between 65and 80 °C. An organism that displays this characteristic is called "thermophilic". [69]

111. Thermoplastic starch (TPS): TPS is a material obtained by disrupting or modifying the internal structure of starch granules when processed with a low water content and the action of shear force and temperature in the presence of plasticizers which do not evaporate easily during the processing. [6]

112. Totally impermeable film (TIF): A multi-layer plastic film with two thin gas impermeable ethylene vinyl alcohol (EVOH) layers embedded in additional layers of standard polyethylene film. The resultant high barrier film is used to reduce emissions during soil fumigation. [83]

113. Transdisciplinary research: Research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem. Transdisciplinary research also engages stakeholders in the conception, implementation, and evaluation of the research. [32]

114. USDA National Organic Program (NOP): Responsible for regulations and guidance on certification, production, handling, and labeling to ensure the integrity of USDA organic products in the U.S. and throughout the world. Organic is a labeling term that indicates that the food or other agricultural product has been produced through approved methods that integrate cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. Synthetic fertilizers, sewage sludge, irradiation, and genetic engineering may not be used. [90]

115. Virtually impermeable film (VIF): A plastic film that contains additional gas-impermeable layers, such as nylon or polyaminides, between the polyethylene layers. Similar to a TIF, but has slightly more permeability. [91]

116. Weathering: The breaking down of rocks, soils, and minerals as well as wood and artificial materials through contact with the earth's atmosphere, water, and biological organisms. [92]

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