NATIONAL FARM WASTE COORDINATION SERVICES

FACT SHEET – MARCH 2024

SOIL BIODEGRADABLE MULCH FILMS

THE PROBLEM

It is estimated that around 12,400 tonnes of conventional mulch films enter the Australian horticulture industry each year. A very small proportion is managed using best practice.

Management costs for plastic mulch are significant including the labour, equipment and fuel use for removal at the end of each crop cycle, space for aggregation, transport for disposal and landfill fees.

Disposal to landfill is currently the most practical option given there are often contaminants (such as soil and plant material) making the plastic mulch very challenging to recycle. As landfill is expensive, growers sometimes manage the material onsite through stockpiling, burying and/or burning. These practices expose the plastic to sun and rain resulting in fragmentation and microplastics entering the soil and water.

Harmful chemicals emitted when burning conventional polyethylene plastic mulch includes soot, solid residue ash, black carbon, and toxic pollutants like dioxins and mercury. These by-products have global warming potential, for example black carbon is 5,000 times greater than CO^2. There is currently no method to account for this environmental burden and the associated costs.

KEY MESSAGES

- Plastic mulch is commonly used for Australian crops such as tomatoes, capsicums, zucchinis, strawberries and in nursery production to retain moisture, suppress weeds and retain fumigation in the soil.
- Plastic mulch is an environmental issue as there is no viable or sustainable disposal and it is usually highly contaminated with plant matter and soil.
- Stockpiling, burying and/or burning on farm is common practice with a high risk of microplastics contamination.
- Certified soil biodegradable mulches (CSBM) are a potential solution which break down naturally in the soil, leaving organic material and no microplastics, and no removal or disposal costs.
- While the upfront cost for CSBM products can be 50% to 200% more than the cost of conventional plastic mulch, there are significant savings from disposal. It is therefore important to consider the whole-of-life cost when selecting these products.

Growers are keen to determine alternatives to plastic mulch given the challenges and costs associated with appropriate disposal and a desire to minimise the impact to the environment.

THE SOLUTION

The opportunity exists to move away from plastics to certified soil biodegradable mulch (CSBM). These products meet the international standard ISO 23517:2021 and will biodegrade into the soil leaving microbial mass and no microplastics.

These mulch films are distinct from conventional polyethylene films. This includes 'oxo-degradable' or 'oxo-biodegradable' mulch films, which are made from fossil fuels derived using non-biodegradable polyethylene and additives that enhance the product's physical disintegration into small plastic fragments which persist in the environment (i.e. microplastics).

Throughout 2010 a range of products were marketed using terms such as 'degradable' and 'oxo-biodegradable' to suggest the material would decompose in-situ. These products were not made from biological material, nor were they certified. In reality, the fossil fuel-based plastics material used in the products included additive(s) to encourage oxidation so that the product fragmented into smaller pieces.

HELPFUL DEFINITIONS

Conventional polyethylene plastic mulches are derived from fossil fuels. They do not biodegrade and must be removed at the end of their use.

Certified soil biodegradable mulches (CSBM) are an alternative to conventional plastic mulches and are made from biological resources such as lignin or corn.

They are tested and certified to biodegrade in the soil, in-situ or ploughed in, where naturally occurring microorganisms completely break down the material into substances found in nature (e.g. carbon dioxide, methane, biomass, water and mineral salts).

There are a number of terms that are important to understand when considering the use of biodegradable mulch. These terms are explained in more detial in Appendix 1.

Ongoing use of plastic mulch can have significant environmental and production impacts such as generating microplastics, loss of topsoil (with the removal of mulch), decreasing soil quality, reduced germination of seeds and harming soil invertebrates[1].

1 Qi, R Jones, D Li, Z Liu, Q & Yan, C 2020, Behaviour of microplastics and plastic film residues in the soil environment: A critical review, Science of The Total Environment, vol 703.

The upfront cost of CSBM is significantly higher than conventional plastic mulches. However, there are future savings from disposal as there is no need to collect, transport and landfill the material. A summary of the key benefits and risks of CSBM products are outlined below (Table 1).

Table 1 Benefits and risks of certified soil biodegradable mulch (CSBM).

Benefits	Risks
• **Reduced plastic:** Reduce the amount of field plastics that are stockpiled/ buried/burnt or sent to landfill, with reduced microplastic pollution. • **Reduce environmental impacts:** Avoids the generation of microplastics that contaminate the environment (soil, vegetation and waterways). • **Production benefits:** Increase soil carbon and reduce the loss of topsoil associated with the removal of conventional plastic film. • **Mitigating future risk:** Transitioning to CSBM can reduce the risk of soil and crop growth issues due to microplastics and increased prices of plastic mulch due to changing oil prices. • **Reduced emissions and transport costs:** As transport to landfill is not required, transport emissions and costs are avoided. • **Significant labour/time savings for the grower:** Installing and removing plastic mulch is estimated to take an additional 6 hours per hectare.	• **Upfront cost of CSBM:** The upfront cost for this product can range between 50% and 200% more than the cost of conventional plastic mulch. • **Misaligned expectations on performance throughout the crop cycle:** There can be unrealistic expectations on how long the CSBM product retains its full structural integrity, with the product potentially biodegrading before the end of the crop cycle. However, the timing of the biodegradation can be adjusted in manufacturing to meet the needs of the growers. Some certified soil biodegradable mulch suppliers have 'questionnaires' they provide to growers before a trial, so expectations are met from the beginning. The life of the product will depend on climate, crop, soil type and other management factors. • **Less flexibility in timing:** Timing of installation is an important consideration, as sometimes growers prefer to install all mulch before consecutive plantings. In this situation, CSBM may degrade slightly before the crop is planted and be more susceptible to tearing. • **Adjusting to the product's structural integrity:** CSBM requires slightly more care to avoid tearing when planting, using machinery or walking around the crop. This is particularly the case if planting occurs after laying the mulch. Growers need to slightly adjust how they treat and use the product to minimise these issues. • **Fumigation limitations:** Some fumigation products may accelerate the degradation of the CSBM and in these cases, the product will not work as required. Suitability of CSBM for fumigation will need to be checked before use.

CASE STUDY

VegNET biodegradable mulch trials in Bowen, Queensland

With reef regulations coming into force in early 2024, growers in northern Queensland have a limited window to ensure solutions are in place to remove single use plastics from farms. To facilitate the move to alternatives, Bowen Gumlu Growers Association (BGGA) and the VegNET Regional Development Officer have prioritised the removal of single use plastics from horticulture farms and the uptake of biodegradable mulch.

The horticultural area of Bowen in Queensland produces tomatoes, watermelons, zucchinis and other cucurbits which all use plastic mulch in production. The BGGA conducted a trial of CSBM in September 2022 to assess its performance, particularly how quickly the mulch started to break down and if integrity was maintained throughout the crop cycle in the warmer months where day temperatures tend to exceed 30°C.

The black BioAgri CSBM product from Biobag was used with watermelon, rockmelons and zucchinis. The mulch supressed weeds and the integrity of the mulch was still good after harvesting. The melons shading the mulch provided protection from UV radiation. At the end of the crop cycle, some holes were evident where microbes had started breaking down the product.

The mulch was ploughed into the soil and by late October was completely broken down into the soil. The yield of the produce was in line with expectations and the performance of the mulch achieved the exact results desired.

Findings from the VegNET trials are being used to educate growers to consider viable alternatives to single use plastic mulch, and encourage them to share their experience with others in the region.

Figure 1 Plastic mulch trial at Bowen, Queensland.

REFERENCES

- AgriFutures 2023: Pre-farm gate waste management – Baseline waste data for the agricultural, fisheries and forestry sector
- Australian Standard 4454-2012: Composts, soil conditioners and mulches
- Australasian Bioplastics Association (n.d.), Certification
- Australasian Bioplastics Association (n.d.), Per- and Polyfluoroalkyl Substances (PFAS) and Certified Compostable Bioplastics fact sheet
- Soil Wealth ICP: Plastics recycling and alternatives to plastic mulch fact sheet
- Landline video: Australia's first certified soil biodegradable plastic mulch

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RMCG

APPENDIX 1

Table 1 Definitions of relevant topics related to soil biodegradable mulch films.

Key terms	Definition
Processes that cause the breakdown of plastic material used in agriculture	• **Biodegrade** is the process where material(s) break down completely into substances found in nature (e.g. carbon dioxide, methane, biomass, water and mineral salts) in a reasonable time frame. Items are generally produced from a combination of organic materials (e.g. starch and cellulose) and chemical additives. Degradation is due to microorganisms. • **Degrade** is the process where a material breaks down or deteriorates chemically. A material is typically called degradable when it breaks down to a certain extent under a particular environmental condition. Most material will degrade given sufficient time and conditions, but this term can be misleading when used to describe a plastic product without qualifying the process in which this occurs. • **Oxo-degrade/oxo-biodegrade** are fossil fuel-based plastics, commonly used in carrier or produce bags, that also include an additive(s) which encourages oxidation so that the product fragments into smaller pieces. This can then be followed by biodegradation, in varying timescales, by fungi and bacteria. • **Fragment** (in the context of this fact sheet) describes the process where plastic fragments into smaller pieces, triggered by ultraviolet radiation or heat, which may be followed by partial or complete breakdown of the material by microbial action. Fragmentable plastic includes oxo-degradable and photo-degradable plastics. • **Photodegrade** is a process where the plastic material degradation is altered via photons. This means that degradation is enhanced by light, typically by sun rays.
Plastic mulch types	• **Biobased plastics** are fully or partially made from biological resources, such as lignin or corn, rather than fossil raw materials. They are not necessarily biodegradable or compostable. • **Fossil fuel-based plastics** are made from fossil resources (oil and natural gas). • **Biodegradable plastics** are designed to decompose under certain conditions at the end of their life. As biodegradable plastic **includes both biobased and fossil fuel-based plastics**, this term on its own can be deceptive and confusing and should be analysed further. Compostable certification provides clarity about when a **'biodegradable'** plastic is made from **'biobased'** sources and thus able to be **'composted'**. • **Compostable plastics** are a sub-set of biodegradable ones, designed to biodegrade under controlled conditions. • **Certified compostable plastics**, in Australia, are items that are certified compostable, and will biodegrade if composting conditions are met in accordance with Australian compostable standards (AS 4736-2006 *Biodegradable plastics – Biodegradable plastics suitable for composting and other microbial treatment* and AS 5810-2010 *Biodegradable plastics – Biodegradable plastics suitable for home composting*. [2]

2 Australasian Bioplastics Association (n.d.), Certification, https://bioplastics.org.au/certification

APPENDIX 1 (CONTINUED)

Topic	Definition
Plastic mulch types (continued)	Key criteria for certified compostable plastics include: • Minimum of 90% biodegradation of plastic materials within 180 days in compost • Minimum of 90% of plastic materials should disintegrate into less than 2mm pieces in compost within 12 weeks • No toxic effect of the resulting compost on plants and earthworms • Hazardous substances such as heavy metals should not be present above the maximum allowed levels • Item should contain more than 50% organic materials • AS 5810 has the same criteria as AS 4736, except acceptable decomposition needs to occur over a maximum of 12 months (rather than 180 days). Since 2021, the certification process asks that the applicant must confirm that no organic fluorinated chemicals, such as perfluorinated and polyfluorinated substances have been added to the material or product. To be certified compostable to either standard, Fluorine levels must be 100ppm or less. [3]
Composting	• **Composting** in a recycling process whereby organic material decompose through microbiological transformation, under controlled aerobic conditions, into a product such as pasteurised or mature compost. [4] • **Commercial composting**, or industrial or large-scale composting, is composting at a scale where inputs of organic material and conditions of moisture, aeration and the carbon-nitrogen ratio are closely monitored and recorded. Typically, this involves technological approaches such as a mechanically turned open windrow, static forced aeration and in-vessel systems.
Microplastics and nanoplastics	• **Microplastics** are defined as solid plastic particles typically smaller than 5mm composed of mixtures of polymers and functional additives. Primary microplastics are micrometre sized solid polymer particles that are deliberately manufactured for specific applications or products (e.g. microbeads used in personal care products). Secondary microplastics instead originate from the fragmentation of plastic waste dispersed in soil and water. • Given that plastic is designed to be durable, the persistence and longevity of plastic in the environment is very high. As disposed plastics break down they become debris and eventually microplastics. This is a long process with estimated half-lives ranging from 58 years for bottles to 1,200 years for pipes. These half-lives and timescales of 100 to 1,000 years indicate that a major fraction of present-day environmental plastic is still in the early stages of degradation. • **Nanoplastics** are often defined as plastic particles smaller than 1 micrometer (0.001 mm). They are heterogeneously mixed and include fibres, granules and fragments. Microplastics turn into nanoplastics overtime.

3 Australasian Bioplastics Association (n.d.), Per- and Polyfluoroalkyl Substances (PFAS) and Certified Compostable Bioplastics fact sheet, https://bioplastics.org.au/wp-content/uploads/2022/11/ABA-Statement-PFAS-2022.pdf.
4 Australian Standard 4454-2012: Composts, soil conditioners and mulches.