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REDUCING AGRICULTURAL PLASTICS' ENVIRONMENTAL IMPACTS

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BACKGROUND AND SIGNIFICANCE

Due to the perishable nature of berries, agricultural plastics are a vital tool for growers to maintain high-quality yields because they shield the fruit from weather, control soil temperatures, and conserve water. However, plastics contribute to climate change and pollution through their intensive production and end-of-life phases.

Post-use, Driscoll's recycles or reuses much of their agricultural plastic waste, but soil-contact plastics in particular pose a challenge because they collect soil residue during the growing cycle, making alternative disposal options economically challenging. Therefore, they are often sent to landfills where they do not decompose. This reduces landfill capacity, resulting in the need to convert more land into landfills.

RESEARCH QUESTION AND OBJECTIVE

Driscoll's sees an opportunity and a responsibility to improve the environmental footprint of their growers' berry production. Their commitment to environmental stewardship encouraged them to partner with the Bren School, where they asked us to help them identify strategies for reducing the environmental impacts of their soil-contact plastic waste.

Research question: What opportunities are there to reduce the environmental impacts of soil-contact plastic waste in berry production?

Objective: Use life cycle assessment (LCA) to measure and compare the environmental impacts of and tradeoffs between different end-of life management options for soil-contact agricultural plastics.

APPROACH

We identified three other disposal options for Driscoll's soil-contact plastic waste: **mechanical recycling, incineration, and plastic-to-fuel,** such as pyrolysis. Mechanical recycling uses machines to wash, melt, and re-shape plastic waste into recycled plastic pellets to be used in other plastic products. Incineration combusts or burns plastic waste and converts the resulting heat into steam and electricity. Finally, plastic-to-fuel involves thermal decomposition to convert plastic waste back into oil-based fuels like diesel and petroleum.

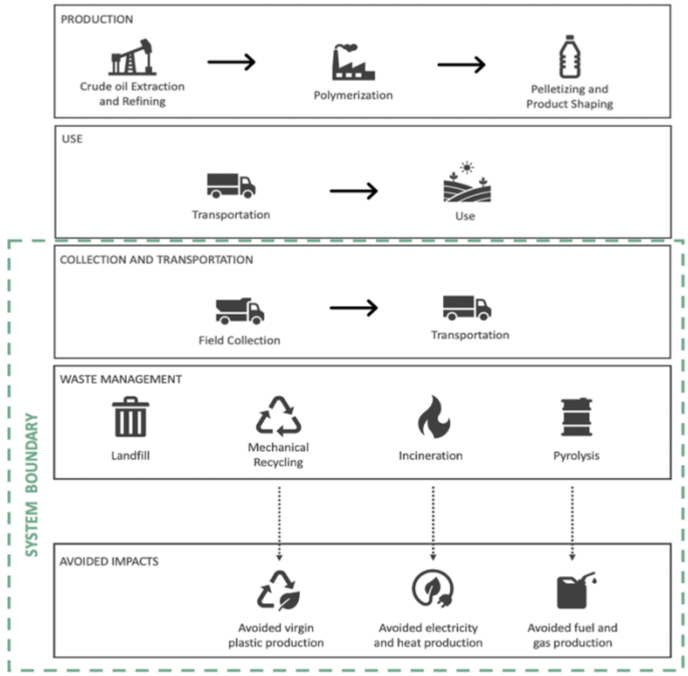
Each of these processes results in environmental impacts, so one might think that allowing plastic to sit in a landfill is the most environmentally friendly option. However, every process except for landfill results in useful end products – mechanical recycling produces plastic pellets, incineration produces electricity, and plastic-to-fuel produces fuels. The benefits of these alternatives come not only from avoiding landfill, but also from their potential to avoid primary production of their useful end products. For example, if recycling one ton of agricultural plastic waste generates one ton of plastic pellets, then we avoid producing that ton of plastic in the traditional, more resource-intensive way.

It is critical to consider the entire life cycle of a process to avoid overlooking key impacts, both positive and negative. To ensure we understood the total impacts of disposal, we conducted a life cycle assessment, or LCA, of each plastic waste management strategy.

LCA OVERVIEW

An LCA involves mapping out the inputs and outputs of every relevant step of a system or process with the goal of quantifying a wide range of environmental impacts, including pollution, natural resource consumption, and greenhouse gas emissions. This allows us to compare the total impacts of a process, instead of only examining one aspect.

We visualize the path that soil-contact plastics take through each scenario in the diagram to the right. Each path begins with field collection, continues with waste management, and ends with avoided production to get a full picture of end-of-life impacts. Because we are comparing waste management strategies, we did not include production and use in our models. We modeled each pathway using data from Driscoll's and three different waste management companies.



RESULTS AND CONCLUSIONS

Impact Category	Landfill	Mechanical Recycling	Incineration	Plastic-to-Fuel
Acidification	4	1	2	3
Ecotoxicity	4	1	3	2
Eutrophication	4	1	3	2
Global Warming	3	1	4	2
Human Health	4	1	3	2
Human Toxicity	4	1	3	2
Smog Formation	4	1	3	2

The table to the left shows the impacts of each process. Dark green cells (1) indicate the least impactful process, followed by light green (2), yellow, (3) and red (4).

Our results show that every process is a net benefit compared to landfill, with the exception of incineration's global warming potential, because burning the plastic releases its embedded carbon. Overall, mechanical recycling is the most environmentally friendly option, followed by plastic-to-fuel, and we recommend Driscoll's pursues both technologies in their sustainable agriculture strategy.

KEY CONSIDERATIONS

While mechanical recycling results in the lowest environmental impacts, it is currently not viable at a commercial scale for soil-contact plastics due to technical and economic constraints. Adoption of each disposal option will depend on economic and technical feasibility and the availability of waste management infrastructure. These are influenced by market dynamics, regulations, and location of operations, so the most appropriate choice for Driscoll's may change along with these factors.

BIG PICTURE

As reliance on plastic continues to grow, end-of-life options will need to expand and adapt to mitigate the environmental impacts of this trend, and Driscoll's will use these recommendations to inform their sustainable agriculture strategy. Our project allows for the comparison of various disposal methods across different indicators, which will allow growers within and beyond the berry industry to make responsible decisions for managing their plastic waste.