Combined Proceedings IPPS 74:413-427. 2024.

Plastic Horticulture Containers: Environmental Impacts and Regulatory Trends

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Keywords: plastic pollution regulation, human health, microplastics, environmental impacts, recovery/recycling, post-consumer recycled (PCR) materials, circular economy, extended producer responsibility (EPR), producer responsibility organization (PRO), consumer packaged goods (CPG)

Summary

A growing body of evidence and public concern over the environmental impacts of plastic pollution and the potential human health impacts of microplastics is driving regulatory actions at international, federal, state, and local levels. These regulations are intended to control the composition and application of plastic products, drastically increase recovery and recycling rates, and prevent misleading or false environmental claims about plastics. These current and coming regulations can apply to plastic manufacturers, propagators, growers, retailers, and marketers in various geographical regions in many different ways. It will become increasingly important for all companies in the horticulture value chain to understand the potential environmental impacts of plastics and how their operations must adjust to how plastics will be managed in the future.

INTRODUCTION

Plastics in Horticulture. Plastics are an essential part of our modern economy. They are lightweight, durable, versatile, strong, abundant, and inexpensive materials often with no viable technical alternatives for many applications. Plastics are a foundational technology for our modern society and a key material for realizing a sustainable future; a necessity for technologies like electric vehicles, solar panels, wind turbines, energy efficient buildings, and so on (Hepburn, 2023). This is no different for the horticulture industry. Plastics are essential materials for horticulture propagation - from containers and trays to films and wraps to tags and labels to irrigation systems, and even as the materials of construction of the greenhouses themselves (Orzolek, 2017).

Yet many of the same properties that make plastic products beneficial during their use contribute to environmental hazards and challenges after their useful life is finished (**Fig. 1**). Plastic's strength, durability, and resistance to the elements means they persist in nature without biodegrading and so accumulate in the environment when not disposed of properly (Greenpeace, 2022). Plastics are mass produced from chemicals derived from petroleum production and so are inexpensive and manufactured in high volumes, about 400 million tons are produced annually (as of 2022) to satisfy growing demand for plastics (Statistica, 2024), (Hofmann, 2023).

Figure 1. There are increasing environmental and regulatory challenges in the disposal of horticultural plastic pots, containers and production materials.

The growing concerns over plastic pollution are driving consumer product companies and retailers to set sustainability goals to reduce or eliminate the use of single use plastics, require the use of increasing amounts of post-consumer recycled (PCR) materials, and for manufacturers to take responsibility for how products sold can be recycled or disposed of after their use (Association, 2020). These same concerns are driving plastic pollution regulations at city, state, federal, and international levels, many of which are now in effect or will be within the next 2 to 7 years (Fowler, 2023). While many of these regulations initially targeted industries like food services or consumer packaging, now plastics used in the horticulture markets are being included and growers are going to have to comply with these new regulations or face financial penalties and/or exclusions from certain retailers or markets.

Plastics are becoming a regulated material. Companies across the horticulture value chain will need to understand their compliance obligations with this new regulatory environment. Understanding how to use and market plastics in a responsible manner will be vital to the success of everyone now and in the next few years.

Decarbonization / renewable energy transition

There is an accelerating global trend to transition the world economies away from fossil fuels and petroleum over the next 10 to 15 years. The Paris Agreement signed in 2015 by 194 nations is a non-binding international agreement to limit the rise in the average global temperature by the year 2100 to less than 2ºC by reducing global CO_2 emissions from the burning of fossil fuels by 45% by 2040 based on a 1990 baseline (UN, 2015). The latest UN IPCC update report shows collective global progress is falling short of achieving this goal. At the COP 27 conference delegates called for an international non-proliferation treaty for fossil fuel production and development (IPCC, 2022). Nations are committing to accelerating decarbonization and reduction in fossil fuel consumptions to try to meet these commitments (Krishnan, 2022).

Many countries, states, cities, and automakers are pledging to stop the production of gasoline and diesel-powered vehicles. Some 30 countries including Canada, UK, and the European Union have banned the sale of gasoline powered passenger cars by 2035 (Plumer, 2021). California, Maryland, Massachusetts, New Jersey, New York, Oregon, and Washington have also committed to the ban by 2035 (Grieve, 2023). Automakers Ford, General Motors, Mercedes-Benz, Volvo, Jaguar Land Rover, and BYD have all pledged to stop the sale of gasoline and diesel-powered cars by 2040 (Miller, 2021). These shifts away from fossil fuels are leading to accelerating growth in renewable energy investments (Ellerbeck, 2023), which is resulting in increased pricing and volatility for electrical and natural gas energy (Frangoul, 2022).

Environmental impacts of plastics

Plastic products impact the environment in many ways, but the primary concern is that they do not degrade but are present in the environment for centuries after they were manufactured and used. Many factors can affect the rate of decomposition of materials in the environment, from the thickness of the finished parts to the aerobic, anaerobic, or aquatic conditions it is exposed to, to how much mechanical shearing and stress it

experiences. The American Chemistry Council (ACS) published a study detailing how long it takes different polymers to break down in the environment under different conditions (Chamas, 2020). According to that study a polypropylene product with an 800µm thickness would take 780 years to degrade in landfill and 87 years to degrade in the ocean. An HDPE product with a thickness of 500µm will take 190 years to break down in a landfill and 58 years in the ocean.

The majority of plastic materials are not collected and recycled; most plastic waste goes to a landfill, incineration, or ends up loose in the environment making its way into surface waters and the ocean. Based on a 2016 McKinsey report annually 330 million metric tons of polymer products were produced globally and about 12% of that volume is recovered, mechanically recycled, and returned to the production process (Hundertmark, 2018). Some 40% is landfilled, 25% is incinerated, and 19% is unmanaged and released into the environment (**Fig. 2**).

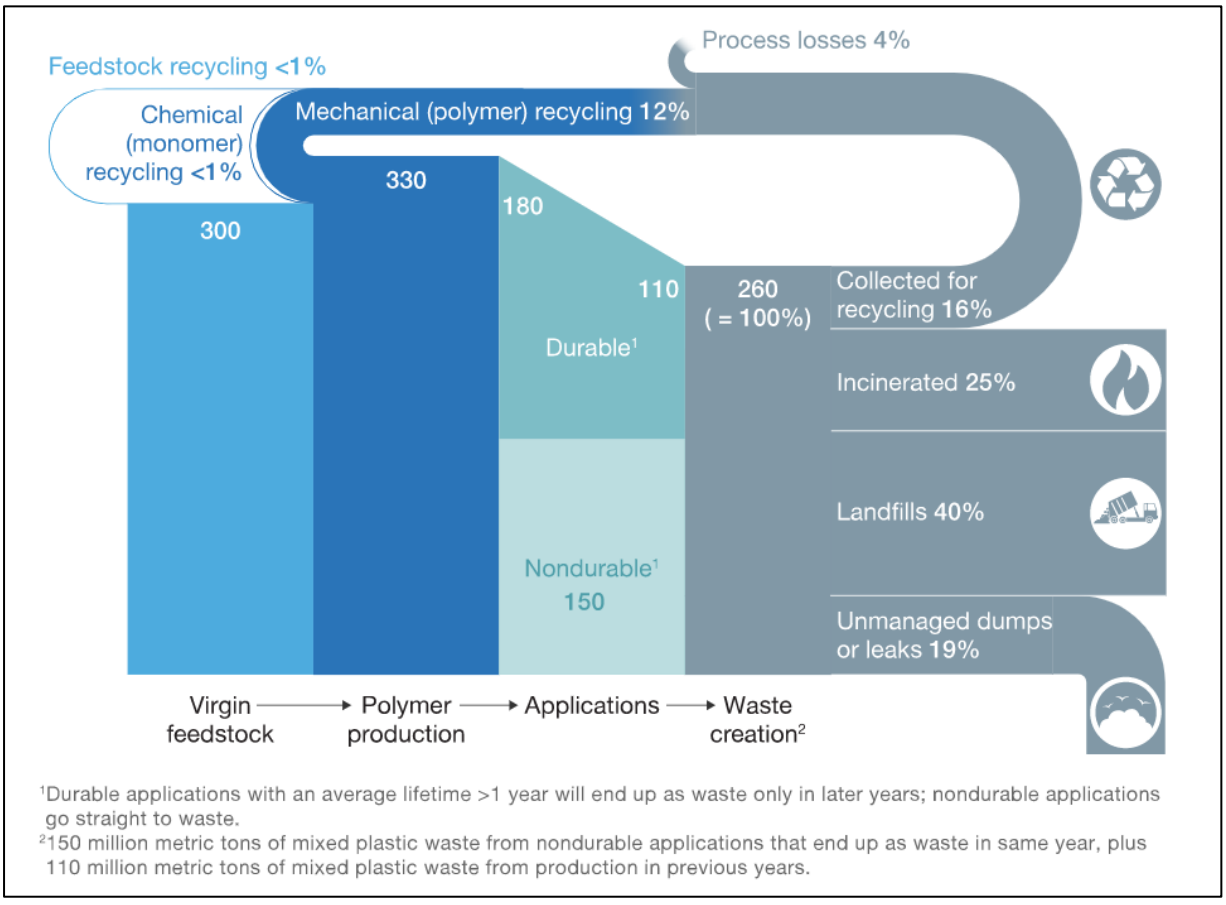

Figure 2: Global polymer flows – millions of metric tons, 2016 (Hundertmark, 2018).

The plastic released into unregulated dumps or released into the environment is accumulating in the world's ocean gyres, which are large areas of little water movement that are the result of the ocean's circulating currents. These collection areas produce what are called "garbage patches," the largest of which is in the Pacific Ocean (NOAA, 2023). A 2015 research paper published in Science found that 8 million metric tons a year are released from land into the oceans, primarily from high-risk geographic areas with unregulated dumps and unenforced environmental standards (Jambeck, 2015). These numbers are increasing annually with both increased plastic production volumes and population growth in these at-risk areas. According to the World Economic Forum's Global Plastic Action Partnership if the rate of release of plastics into the world's oceans continues at the current rate by 2050 the total amount of plastic in the ocean by weight will be greater than the total weight of fish in the ocean (GPAP, 2023).

As a result of these environmental releases microplastic particles are being detected in the environment including in drinking water and food (Koelmans, 2019). Another 2021 study published in Environmental Science and Technology estimated that humans inhale or ingest between 0.1mg and 10mg of microplastics per day, which is the equivalent to eating at minimum a credit card amount of plastic every month (Nor, 2021).

The long-term human health impacts from microplastics are an area of emerging study and concern, with some studies finding microplastics accumulating in human tissues. Recent studies have shown the presence of microplastics in 60% of fatty plaque deposits in human heart arteries (Liu, 2024), the presence of microplastics in arteries correlated to a 400% increase in the risk of stroke or heart attack in those who had microplastics in their bodies (Marfella, 2024), and 100% of human placentas tested showed the presence of microplastics (Braun, 2021).

These emerging concerns over the environmental and human health impacts of plastic pollution has made plastics very unpopular among the public and has produced widespread public support for regulations that hold manufacturers and producers responsible for taking actions to reduce the potential plastic pollution impacts of their products. A worldwide public opinion poll of 20,000 respondents across 28 countries conducted by IPSOS in 2022 found that of those surveyed 85% want manufacturers and retailers to be held responsible for reducing, reusing and recycling plastic packaging, 82% favor product with less plastic packaging, 90% favored an international treaty that would address plastic pollution (IPSOS, 2022). Another poll conducted by IPSOS on behalf of Oceana in 2023 of 1,000 US voters across all 50 states found that 80% of voters are concerned about single-use plastic products and are in favor of requiring companies to reduce plastic packaging (Oceana, 2023). These growing concerns over the environmental and human health impacts of plastic pollution are driving the public aversion to single use plastics and accelerating plastic pollution regulatory actions.

Plastic pollution prevention regulations

There is a lot of activity at the international, federal, state, and local levels to address plastic pollution concerns and transition plastics to a circular economy where recovery and recycling is drastically increased

compared to the present. Some of the relevant regulations for horticulture plastics are listed (**Table 1).** These regulations can be grouped into four categories:

Material Requirements These are regulations that control or restrict the material properties or compositions of plastic products and their applications. Examples of these kinds of regulations are bans for the use of plastics in certain markets like shopping bags or food service containers, eliminations of components or chemicals of concern like PFAS or expanded polystyrene, and requirements for minimum recycled material content percentages. Examples of these include New Jersey S-2515 and Maine LD-1504.

Extended Producer Responsibility (EPR) These are regulations that intend to pass costs for the collection and disposal of plastic products up the value chain to producers and manufacturers. This requires companies to disclose the amount of single use or packaging plastics sold into those states to regulators and then pay fees based on those amounts. These fees are structured to encourage transition to more sustainable materials or lower weights of materials. Examples of these include Colorado HB22-1355 and Oregon SB-582

Truth in Advertising These are regulations that restrict and control the environmental benefit claims that producers, marketers, and manufacturers can use for their products. The goal is to eliminate misleading or unsupported claims for terms such as "recyclable" or "compostable" and associated symbols like the use of the "chasing arrows" recycle symbol. Examples of this include California SB-343 and the FTC Green Guides

Environmental Risk or Impact Disclosure Requirements These regulations require larger corporations to assess and disclose environmental impacts and risks such as their climate change related risks to operations and their greenhouse gas emissions. These risks can include purchased goods or value chain risks in addition to the risks of the operations of the company itself. Examples of these regulations include California SB-253 and SEC's ESG final disclosure rules.

One of these growing trends is for states to regulate single use plastic products and phase out their use in specific applications or markets to address impacts from plastics accumulating in the environment. The United Nations passed a resolution in 2022 committing to create a binding treaty to eliminate plastic pollution and begin the process of ratifying it by 2024 (Nations, 2022). Canada has banned the use of plastic in specific food service items and identified "carbon black" as a plastic colorant specifically as unacceptable due to recyclability challenges (Canada, 2023). Connecticut, California, Delaware, Hawaii, Maine, New York, Oregon, and Vermont and many cities including Miami, FL and Charleston, SC have all banned different kinds of single use plastic products like drinking straws or plastic shopping bags (Richard, 2023).

Canada and states like New Jersey are enacting laws requiring minimum percentages of *post-consumer recycled material (PCR)* in plastic products (Quinn, 2022). These laws include ramp up schedules with requirements for manufacturers to demonstrate to state regulators that their plastic products contain increasing proportions of PCR in future years. The intent of these laws is to generate demand and revenue for curbside recycling facilities, thereby increasing recovery rates and reducing the amount of plastic landfilled or entering the environmental uncontrolled.

Table 1: Pending plastics legislation relevant to the horticulture industry.

Regulation	Effective Date	Implication to Producers
New Jersey S-2515	Jan 2024	Require 10% post-consumer recycled content in 2024 ramping up to 50% by 2035. Registration completed by Jan 1, 2024.
California SB-343	Fall 2025	Removal of chasing arrows, restrictions on use of "recyclable" claim.
Colorado HB22-1355	Jan 2025	Pay fees for plastics sold into state – reporting requirements
Oregon SB-582	July 2025	Pay fees for plastics sold into state – reporting requirements
Canada Plastics Registry	2025	Register and report quantity of plastics sold into the country. Removal chasing arrows, qualifications for recyclability claims. Prohibit claim of degradable or compostable without 3rd party cert.
California SB-54	2026 thru 2032	Rules to be finalized Jan 1, 2025, pay fees for plastics sold into state – reporting requirements, required recovery rates for plastic materials
Canada Plastics Registry	2026	Requires 20% PCR in rigid containers by 2026, ramping up to 60% PCR.
Maine 2146	2027	Pay fees for plastics sold into state – reporting requirements
Maine LD-1504	Jan 2030	Ban sale of intentionally added PFAS of any kind from all products sold in the state, except "unavoidable use" by Jan 2030.
UN Plastic Pollution Treaty	2030+	Negotiations are continuing. Ratification and timelines not yet available

Another plastic pollution trend is *Extended Producer Responsibility (EPR)* legislation that requires producers to report to state agencies on the quantity of plastics sold in the states and pay fees to compensate the states for managing the plastic waste. The framework for these laws includes the selection of a non-governmental organization called a *Producer Responsibility Organization (PRO)* to represent industry to the state regulators and work to set reduction and recovery targets, collect fees from manufacturers, and report on progress against industry goals to the states (Packaging, 2024). Maine, Colorado, Oregon, and California have already passed EPR laws and are in the process of enacting rules while 15 other states have EPR laws submitted to state legislatures for consideration (Felton, 2022).

The Federal Trade Commission, Canada, and several states like California are taking regulatory action against false or misleading product environmental claims called greenwashing (Brooks, 2019). These actions require producers to provide documented support for environmental claims like a claim that a plastic product is "recyclable" and avoid the use of misleading symbols or language. One target of this is the "chasing arrows" symbol around the Resin Identification Code (RIC), often embossed by manufacturers on plastic products (California, 2023). The intention of the RIC symbol is to indicate to consumers and recyclers what type of plastic the product is made of. The problem is that most consumers identify the "chasing arrows" symbol as meaning the product is recyclable regardless of the resin type or how commonly the products are accepted for recycling, and so has become misleading (Davis, 2024). Another target is the claim that products are "recyclable" without evidence that the products are actually being recovered and recycled (Keller Heckman LLC, 2023). So in decades past the term "recyclable" might have meant that the plastic material was technically capable of being recycled regardless of the economics of recycling, and now these regulations are re-defining "recyclable" as meaning that the products are actually being recycled in significant percentages and with large proportions of the population having access to recycling resources for those products (Mallen, 2021).

The Retailer Industry Leaders Association (RILA) has a Retail Compliance Center that is monitoring and communicating plastics regulations that are material to retailers. Many of the coming regulations are listed in their December 2022 Fact Sheet (RILA, Dec 2022). The Association of Plastic Recyclers (APR) are also tracking developments in these regulations and regularly communicating these on their website in blogs and guidance documents (APR, 2023).

The result of these coming changes is that plastics are essentially becoming regulated materials like toxic chemicals or hazardous wastes (Polman, 2023). This will create a need for regulatory compliance resources and infrastructure for plastic producers and their suppliers. This could also mean increasing competition for recycled materials that follows the mandated PCR content requirements, which would result in price increases and volatility in demand increasing before supply can catch up.

Growers are already expecting the prices of plastic container to increase significantly and impact their businesses. According to 2023 the industry survey done by Greenhouse Growers 93% of growers expect an increase in plastic container costs with 36% of respondents anticipating an increase greater than 11% (Greenhouse Grower, 2023). The 2023 price index report done by AmericanHort found costs for inputs increased 59.8% between 2007 and 2022 and project a 3.5% increase in overall costs for growers, stating that "the leading input cost increases are for containers and other plastics, freight and trucking, propagative materials, fertilizers, fuel and energy, and, of course, labor" (Hall, 2023).

Retailers have been making significant commitments in the past 3 to 5 years with respect to single use plastics. Many retailers have set goals to remove undesirable plastics like expanded polystyrene (EPS) or polyvinyl chloride (PVC) from their packaging, reducing weight and amounts of plastics, and increasing PCR content for plastic packaging. The Consumer Brands Association (CBA) in 2020 compiled the sustainable packaging commitments of the top 25 consumer brands (Association, 2020). The goals of some of the more relevant consumer brands are summarized (**Table 2).**

The Home Depot published their Responsible Product Standards in late 2021 (Depot, Oct 2021). In this guidance document they make say that plastic packaging should be made with rPET, PET, HDPE, or PP and should avoid EPS or PVC. They state that they will require a minimum of 5% PCR content in plastics and a minimum of 30% PCR content in corrugated / paper products. They also state in this guideline that suppliers should utilize bio-based plastics and materials where packaging efficacy will not be compromised. The Home Depot highlights several 3rd party ecolabel certifications that they recognize including ones for recycled content and biobased content.

Lowe's stated in their 2021 Corporate Responsible Report (Lowe's, 2021) that they are forming internal task forces to look at removing EPS and PVC from their packaging, that will include sustainability claims and features in their buying guidance documents, and "are exploring ways to communicate [their] sustainability values to [their] customers and showcasing how customers can enhance their home's sustainability profile, including ways to reduce their carbon footprint." They also state "[They] are also increasing [their] communication with suppliers at the onset of product development to increase recycled content going into products and packaging."

Table 2: Consumer Brand Association - consumer packaged goods (CPG) sustainability commitments.

CPG Companies	Packaging Sustainability Commitments
Newell Brands	Use at least 20% non-virgin (recycled content) in plastic packaging for Newell manufactured goods by 2025.
Procter & Gamble	P&G committed to achieve 100% recyclable or reusable packaging by 2030. They will also reduce global use of virgin petroleum plastic in packaging by 50% by 2030.
Nestlé	Nestlé has committed to 100% recyclable or reusable packaging by 2025 and will reduce the use of virgin plastics by one third by 2025.
Unilever	Unilever committed to making all its plastic packaging fully reusable, recyclable or compostable and increasing recycled plastic material content to 25% by 2025.
Henkel AG	By 2025, 100% of Henkel's packaging will be recyclable or reusable and the use of virgin plastics will be reduced by 50%.
Keurig Dr Pepper	By 2025, 100% of Keurig Dr Pepper's packaging will be recyclable or compostable and use 30% post-consumer recycled content.
RB	By 2025, all RB packaging will be 100% recyclable or reusable and include at least 25% recycled plastic content.
PepsiCo, Inc.	By 2025, PepsiCo strives to design 100% of packaging to be recyclable, compostable or biodegradable and reduce virgin plastic use across its beverage portfolio by 35%.
SC Johnson	Make 100% of plastic packaging recyclable or reusable by 2025, increase the percentage of PCR plastic used in our North American and European bottles from 20% today to 40%.

Horticulture challenges with plastics

The future trends for growers and producers using plastic products is for those companies to be required to be increasingly held accountable for the environmental impacts of those products (Giordano, 2022). Producers will need to take active roles in ensuring that the plastic product they purchase and market are compliant to various regulations, include recycled content including required amounts of PCR, that the products are easily recycled in most geographic areas, and that their environmental related marketing claims are credible and transparent.

Many challenges to the recyclability of plastic products exist for horticultural products include:

- The use of mixed materials or laminates such as the integration of reinforcing fibers that do not separate during mechanical recycling.
- The inclusion of labels with adhesives that do not easily detach and separate during recycling.
- Vacuum or thin film products that cannot easily be mechanically chipped or flaked (Greenpeace, 2022).
- Inclusion of chemicals of concern like PFAS in inks or coatings (Whitehead, 2023).
- Colorants like carbon black that are commonly used in horticulture products make the plastic invisible to optical sorting equipment used by recyclers to sort materials. (Cheippo, 2020).
- Ensuring symbols and marketing messages regarding recyclability and environmental impacts are compliant to regulations, credible, and supported with data (Brooks, 2019), (Americover, n.d.)

As the horticulture value chain moves to keep up with the need to be more sustainable, more transparent, and more coordinated as an industry, it will be increasingly important for everyone to take an active role in managing what they purchase, produce or manufacture, and sell is complying with these ever changing and sometimes confusing regulations and customer / stakeholder expectations (Hudson, 2023).

CONCLUSION

In the coming years, the horticulture industries in the United States and Canada, which utilize plastics, will encounter numerous challenges and opportunities. Current trends indicate over the long term that plastics will encounter supply disruptions, price volatility, consumer desire for more sustainable products, and increased regulatory pressure. Plastic pollution has become a major concern for government regulators and consumers in the last few years and continues to grow in significance. Many new laws and regulations are being enacted that will both increase the costs of plastic products and require recyclability and recycled content. Consumers, particularly Millennials and Gen Z, are increasingly concerned over the environmental impacts of plastics and are viewing sustainability as a "have to have" feature or aspect of purchased products.

To be ready for the coming years all companies in the horticulture value chain will need to develop internal capabilities, systems, and business practices to manage the challenges and risk associated with plastic products. They will need to be able to quantify and report specific environmental data to customers, stakeholders, and regulators, and lastly, they will need to take steps to maximize the recyclability and

minimize the environmental impacts of their products to meet consumer and evolving customer requirements. In the end these necessary changes will help to reduce the environmental impacts plastic products can have and help move us to a more sustainable future.

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