

DISPOSAL AND END-OF-LIFE

Downstream Pathways for
Packaging in North American
Fresh Produce Supply Chains

The end-of-life pathways for fresh produce packaging are highly dependent on the material and composition of the packaging, paired with the subsequent availability of adequate conveyance and infrastructure for proper disposal. The challenge at the end-of-life of packaging is ensuring proper aggregation and disposal. When mishandled, improper disposal can lead to contamination in recycling streams, landfill accumulation, or pollution in the environment.

As the major end user, consumers play a key role in determining the fate of fresh produce packaging at the end of its life cycle. Once packaging leaves the supply chain and enters the hands of consumers, its disposal relies on millions of individual households navigating the complex web of disposal streams, regional infrastructure availability, and deciphering the appropriate outlets for these diverse materials (1). For example, Polylactic Acid (PLA) is a biopolymer that can be indistinguishable from a conventional polymer, such as polyester. While PLA is a compostable material, if it mistakenly goes into the waste stream of polyester, a recyclable material, it will contaminate the polyester waste stream. However, consumers may not have the waste conveyance infrastructure available, such as regional curbside pick-up, or ability to differentiate between these materials.

It is important to understand and address these end-of-life pathways to guide decision-making and improve sustainability outcomes of fresh produce packaging. The full life-cycle considerations of fresh produce packaging decision-making fall under three pillars: the environmental cost of creating the packaging (upstream), the core role of protecting the contents (functionality), and the end-of-life management (downstream). This paper will focus on the downstream considerations critical in mitigating pollution and conserving resources, as well as the harsh reality of where packaging waste can end up.

Facilities

Materials Recovery Facility (MRF)

A Materials Recovery Facility (MRF) is a specialized facility that sorts and processes recyclable materials from various waste streams such as mixed recycling bins or even general trash (2). The MRF's role is to separate these incoming materials, recovering valuable recyclables like paper, glass, and metal, which are then baled and sold for manufacturing (3). However, food packaging contaminated by food waste, multilayer plastics, or non-recyclable bioplastics often cannot be recovered (4). These materials, known as residuals, are disposed of in a landfill or through other means.

MRFs serve as hubs that direct packaging into multiple end-of-life pathways, including mechanical recycling, chemical recycling, industrial composting, or incineration. This process maximizes material recovery and minimizes landfill disposal. Landfilling is generally not a primary function of MRFs, which are designed to divert as much waste as possible into higher-value recovery systems. For fresh produce packaging, recyclability depends heavily on proper consumer sorting and the capabilities of local MRF infrastructure.

Landfills

Landfills are engineered facilities designed to contain and isolate waste from the surrounding environment (5). While they remain the most common waste management method in the United States, they pose significant sustainability challenges. Packaging that ends up in landfills is effectively removed from the resource cycle, contributing to long-term accumulation of waste. When packaging contains food residue, it decomposes anaerobically in landfills, releasing methane, a greenhouse gas more potent than carbon dioxide (CO₂). Fresh produce packaging, even when it is made from compostable or recyclable materials, loses its environmental benefit if it is disposed of in a landfill.

Technologies

Mechanical Recycling

Mechanical recycling is the most established process for managing packaging waste (6). It is commonly facilitated by MRFs and involves collecting, sorting, cleaning, and reprocessing materials such as plastics into pellets or flakes that can be used to manufacture new products (7). This process works best with single-material streams such as polyethylene terephthalate (PET) clamshells or high-density polyethylene (HDPE) containers. However, multilayer films, contamination with food residue, and inconsistent collection systems reduce recyclability rates. Successful recycling of fresh produce packaging depends on consumer sorting and the ability of MRF's to separate clean, high-value plastics from mixed waste streams.

Chemical Recycling

Chemical recycling refers to a group of advanced technologies that break down plastic waste into its basic chemical building blocks, enabling the creation of new plastics or other raw materials (8). Unlike mechanical recycling, chemical recycling can handle contaminated or complex materials, such as multilayer films or flexible plastics, that would otherwise end up in landfills or incinerators. This technology supports a more circular economy by expanding the types of materials that can be recycled, but it requires significant energy input and infrastructure investment. Within MRF systems, chemical recycling pathways are emerging as complementary to mechanical recycling, providing an outlet for materials that are otherwise unrecoverable.

Incineration

Waste incineration is the controlled burning of waste at high temperatures in specialized furnaces called incinerators, significantly reducing the volume of the waste (8). Some facilities capture the heat generated to produce energy, a process known as waste-to-energy (9). While incineration prevents waste accumulation in landfills and can recover some energy, it can come with drawbacks. These drawbacks can include the emissions of greenhouse gases and pollutants, high operational costs, and the loss of material resources that could otherwise be recycled or composted. More advanced systems are able to capture emissions efficiently. In certain regions, MRFs are connected to a waste-to-energy process, directing residual packaging materials that cannot be mechanically or chemically recycled into incineration facilities. For fresh produce packaging, incineration represents a trade-off between volume reduction and the forfeiture of circular economy benefits.

Industrially Compostable

Industrial compostable packaging requires high-heat, oxygen-rich environments found in commercial composting facilities. These facilities maintain temperatures between 55-70°C (131-160°F) and usually break down the materials in a few weeks to a few months depending on the material type and composting method. Industrial composting facilities can effectively process bioplastics and coated fiber packaging alongside food scraps, diverting organics from landfills and reducing methane emissions. However, access to industrial composting infrastructure in the U.S. is limited and regionally inconsistent. Though not yet widely established, some MRFs act as sorting hubs that direct compostable packaging to regional composting facilities when infrastructure is available. Some advanced facilities make use of depackaging machines, which can be costly but effective in separating food waste from packaging. Also, commercial composting facilities often rely on disposal or tipping

fees, contracts with local governments, and compost sales to support their operations. Without proper collection and processing, compostable packaging often ends up in landfills or incinerators, canceling out its intended benefits. Successful composting of fresh produce packaging will depend on expanded infrastructure and clear labeling to ensure consumer compliance.

Home Compostable

Home compostable packaging is designed to break down in backyard composting conditions, which occur at lower temperatures and slower microbial activity compared to industrial facilities. The compost process in a backyard setting generally generates temperatures around 50-65°C (122-149°F) and typically takes 6 to 12 months to break down compostable products and materials (10). For consumers, composting at home offers a convenient way to divert organic packaging waste from landfills (11). However, challenges include inconsistency in composting conditions across households, the risk of packaging not fully breaking down, and consumer confusion around labeling. For fresh produce packaging, home composting works best for small-volume, fiber-based items but is challenged by larger or multilayer packaging.

While each disposal pathway leads to different environmental outcomes, none are a “silver bullet” solution. Recyclability and compostability only provide benefits when paired with accessible infrastructure, clear consumer education, and policy alignment. For the produce industry, optimizing end-of-life outcomes requires not only designing packaging with disposal in mind but also aligning those designs with real-world systems. The SPPA initiative emphasizes that truly sustainable packaging must balance functionality, food waste prevention, and realistic disposal pathways to make a meaningful environmental impact.

References

1. [An Assessment of the U.S. Recycling System: Financial Estimates to Modernize Material Recovery Infrastructure](#)
2. [What on Earth is the MRF? - Western Placer Waste Management Authority](#)
3. [How-MRFs-Work_SPC.pdf](#)
4. [Bioplastics: The Good, The Bad - The Not Recyclable — Recycle Right NY](#)
5. [Basic Information about Landfills | US EPA](#)
6. [Plastic Waste Recycling? A Chemical Recycling Perspective | ACS Sustainable Chemistry & Engineering](#)
7. [Mechanical Recycling of Thermoplastics: A Review of Key Issues](#)
8. [Waste Incineration Overview - Waste Incineration & Public Health - NCBI Bookshelf](#)
9. [Energy Recovery from the Combustion of Municipal Solid Waste \(MSW\) | US EPA](#)
10. [Home Compostable vs Industrial Composting: What's the Difference?](#)
11. [Composting At Home | US EPA](#)

Additional Resources

MRF

- [Materials Recovery Facilities \(MRFs\) - HSE](#)
- [National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA](#)

Landfilling

- [What Are Landfills? - The Institute for Environmental Research and Education](#)

Composting

- [Approaches to Composting | US EPA](#)

Chemical Recycling

- [Chemical Recycling: State of Play](#)
- [The Chemical Recycling of PLA: A Review](#)

Mechanical Recycling

- [Challenges in the mechanical recycling and upcycling of mixed postconsumer recovered plastics \(PCR\): A review](#)

Incineration

- [Incineration: The Basics of Burning Waste for Energy](#)



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