Produce Sticker Final Report

A Status Assessment of Produce Sticker Technologies

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[1] https://fortress.wa.gov/ecy/publications/SummaryPages/2507041.html
[2] www.ecology.wa.gov/contact

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Glossary

ASTM	American Society for Testing and Materials
BOMA	Business Organics Management Areas
BPI	Biodegradable Products Institute
CCA	Climate Commitment Act
CCC	Compost Council of Canada
CFU	colony-forming unit
CMA	Compost Manufacturing Alliance
CO_2	Carbon Dioxide
CPMA	Canadian Produce Marketing Association
CPO	Compost Procurement Ordinances
CROP	Contamination and Reduction Outreach Plan
CRP	Compost Reimbursement Program
Ecology	State of Washington, Department of Ecology
EPA	U.S. Environmental Protection Agency
EPP	Environmentally Preferable Purchasing
EU	European Union
FDA	U.S. Food and Drug Administration
FTC	Federal Trade Commission
ICA	International Compost Alliance
IFPS	International Fresh Produce Standards
ISO	International Organization of Standardization
NAAS	National Agricultural Statistics Service
NOP	National Organic Program
OML	Organic Management Laws
OMRI	Organic Materials Review Institute
PFAS	per- or polyfluoroalkyl substances
PLU	Price look-up
POD	print on demand
PPDL	Plastic Product Degradability Law
PPWR	Packaging and Packaging Waste Reduction Act
RCW	Revised Code of Washington
SWMP	Solid Waste Management Plan
TF	total fluorine

USDA	United States Department of Agriculture
WSDA	Washington State Department of Agriculture

Executive Summary

Produce stickers, or PLU (price look-up) stickers, pose a critical issue to composters. They are an unmanageable source of contamination coming in with pre- and post-consumer food waste. The U.S. Plastics Pact Member Activators list non-compostable produce stickers as a "Problematic and Unnecessary Material."

Washington's "Organic Management Laws" (OML) establish a comprehensive plan of action for organic materials management. House Bill (HB) 2301, Section 401, required a study addressing the status of produce sticker technologies. This report is a result of that directive. The findings of this study will be used by the State of Washington, Department of Ecology (Ecology), in consultation with the Washington State Department of Agriculture (WSDA), to compile a summary report to the legislature that will address compostability, toxicity, cost, printability, product performance, legal barriers, production logistics, and impacts of alternative PLU stickers to farmers, composters, and other key industry stakeholders. The summary report sent to the legislature is Ecology Publication 25-07-041.

Greene Economics used a two-tier study approach. We started with an initial understanding of the background and history of HB 2301, and reviewed reports and research available from secondary sources. Principal research involved an in-depth stakeholder outreach and engagement process with key actors including Ecology, WSDA, produce farmers-packers-distributors, standard setting and certifying bodies, sticker and adhesive producers, Washington compost facility operators, and other jurisdictions with restrictions on non-compostable produce stickers.

One of the most critical findings from the outreach process was a well-established collaboration underway with jurisdictions who have already taken legislative steps to ban plastic produce stickers. These stakeholders are coordinating regularly to create international standards. This will support developing compostable stickers that meet the existing diversity of legislative rules and provide standards for countries such as Canada and states in the U.S., who are considering rules.

A recent meeting held in Niagara Falls, Ontario, Canada on October 1, 2024, included leaders from the produce, compost, and sticker manufacturing industries. The meeting resulted in guidance for international standards and an ongoing working group to establish and institute worldwide regulations. Attendees, including the International Compost Alliance, requested that states and countries coordinate to share international standards for produce stickers rather than establishing individual regulations, which can create competing standards. Such competing standards could limit manufacturing and cost efficiencies and create limitations for international produce trade.

The focus on compostable stickers in these international collaborations align with the technology comparisons in this report. We found that compostable stickers are the most viable option to replace plastic stickers at this time. We compared key criteria like compostability, toxicity, printability, and performance for plastic PLU stickers and potential alternatives like compostable stickers, ink-based printing, and laser etching, to see if they could serve the same labeling and tracking purposes.

In addition, other results point to compostable stickers as the only feasible alternative to replacing plastic stickers. Other alternatives such as laser printing and ink marking face multiple barriers including scalability and functionality. Furthermore, international momentum to develop compostable stickers suggests industry leaders are already moving in the direction of compostable stickers in response to

concerns about plastic contamination. The very small number of global sticker producers are involved in global conversation about international standards.

We conclude the following for each alternative produce sticker technology:

Plastic Stickers: Plastic stickers cannot be removed effectively from produce at a compost facility, and they end up in the finished compost product as a visual and plastic contaminant. Given the negative impacts of plastics in the environment, there is a global movement to use compostable stickers to replace plastic stickers.

Compostable Stickers: Compostable stickers are the alternative chosen by countries moving away from plastic stickers including members of the European Union, Australia, New Zealand, and Canada. Compostable stickers can be used in the current stickering infrastructure, and there are already two major sticker producers who have compostable stickers ready for use now. International standards for compostability is critical because produce is traded internationally.

Laser Etching and Ink-Based Printing: There are no known operations for either of these technologies. Use of either technology would require a complete infrastructure conversion, so these options are not currently feasible. Challenges for laser etching include readability on diverse produce types, and breaking the produce skin, which leads to water loss and bacterial vectors. Ink-based printing does not work on rough skinned produce, and vegetable inks are not durable through the handling and washing process. More effort is being put into developing compostable stickers and adhesives rather than improving laser etching and ink-based printing.

Based on available technology and input from key stakeholders, we recommend Washington wait to ban plastic stickers or require compostable stickers. This aligns with current international collaboration and allows for the following to happen:

- Develop more options of compostable stickers that meet state and international standards for compostability, performance, and toxicity.
- Develop compostable adhesives that meet the 95 percent performance standard for adhesion.
- Develop compostable thermal paper for use in print-on-demand systems.
- Reach economies of scale that allow for price reductions from current cost increase estimates.
- Develop tools and strategies to help farmers and composters stay up to date on standards for stickers and laws around exports.
- Allow The National Organic Program (NOP) to consider potential changes and allow compostable stickers as a feedstock for compost used on organic farms.
- Use and adopt international standards for compostable stickers, in addition to ASTM standards, to align with more stringent international laws.

We also recommend Washington participate in the international conversation about global standards for produce stickers. Washington farmers must understand the impacts of international actions for imports and exports. In addition, the international working groups would provide access to the most up to date information in a highly dynamic marketplace.

Introduction

Produce stickers, or PLU (price look-up) stickers, pose a critical issue to compost programs and are seen as an unmanageable source of contamination. They come in with both pre-consumer (e.g. produce packing facilities and grocery stores) and post-consumer (e.g. residential and business organics collection) food waste. In 2022 and 2024, Washington took legislative action to address the issue of compost contamination by passing HB 1799 and HB 2301, respectively. These bills are referred to as the "Organic Management Laws" (OML) and were drafted to support the Climate Commitment Act (CCA). The OML established or amended more than 20 other state laws to establish a comprehensive plan for managing organic waste across Washington.[3]

HB 2301, Section 401 states that: "The department of ecology, in consultation with the department of agriculture, must carry out a study and submit a brief summary report to the legislature by September 1, 2025, addressing the status of produce sticker technologies, including produce sticker options that do not contain plastic stickers or adhesives or that otherwise meet compostability standards."[4]

The Department of Ecology (Ecology) hired Greene Economics, LLC (Greene Economics) to conduct a comprehensive study of produce sticker technologies as they relate to solid waste, recycling, and compost management systems. This study is conducted under Ecology contract no. C2500042: Produce Sticker Study, issued under the provisions of Department of Enterprise Services' statewide contract no. 22222: Environmental Consulting Services.

The findings in this report were summarized in a report to the legislature by September 1, 2025 (Publication 25-07-041).

Purpose

The purpose of this report is to present a comprehensive look at produce stickers and other related technologies with an analysis of compostability, toxicity, cost, printability, product performance, legal barriers, production logistics, and impacts to compost and/or recycling facilities. The study addresses features of stickers and other potential produce labeling technologies, such as ink-based printing, laser etching, or other embedded solutions. We evaluate these technologies in terms of their pros and cons across a variety of metrics, including how likely they are to contaminate compost, or put microplastics in the environment. We also looked at costs, logistics, printability, performance, policy barriers, opportunities, and other relevant factors.

Approach and Methodology

Greene Economics used a two-tier approach to gather information and data for this study. We first developed an initial understanding of the background and history of HB 2301, and the underlying issues related to produce stickers through a review of reports and studies. Both Ecology and Washington State Department of Agriculture (WSDA) staff provided research. In addition, we reviewed other reports, data,

[3] https://apps.ecology.wa.gov/publications/documents/2307003.pdf
[4] https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Bills/Housepercent20Passedpercent20Legislature/2301-S2.PL.pdf?q=20250224042436

and documents in the process, like reports from other stakeholders about produce sticker technologies and laws in other states and countries.

Our second tier included in-depth stakeholder outreach and engagement (see Chapter 3 for more details). We talked to sticker and adhesive producers, researchers, and other experts to get an understanding of the current technologies and how feasible they are for producers and other stakeholders. Project members identified key leaders and stakeholders to interview, so we could understand industry needs, constraints, and opportunities. We integrated the results into this report's findings.

With the information from desktop research and stakeholder outreach, we compiled an in-depth review of produce sticker technologies including those that are emerging. Some technologies do not contain plastics or adhesives or have other ways they meet compostability standards. The project team considered many factors related to produce stickers, produce sticker adhesives, ink-based printing, laser etching, and other potential technologies that help label and track produce.

Overview and Background

Produce stickers are an unmanageable source of contamination at compost facilities. Stickers come in from both pre-consumer (e.g. produce packing facilities and grocery stores) and post-consumer (e.g. residential and business organics collection) food waste streams. At least one facility reported that plastic produce stickers result in truckloads of produce being turned away,[5] so it goes to the landfill and emits methane gas into the atmosphere.

Produce stickers are made of three key components: adhesive, labeling ink, and facestock (the material holding labeling ink on one side and adhesive on the other, typically made of paper or plastic) (see Figure 1).[6] In the United States, all three components must be food grade according to the U.S. Food and Drug Administration (FDA). However, "food grade" does not mean "compostable." While facestock can be made from compostable materials like paper, the sticker contains layers of adhesive and ink that can be incompatible with the composting process.[7]

[5] Kachook, Olga. 2021. Produce Stickers: A Small but Mighty Problem. https://sustainablepackaging.org/2021/05/05/produce-stickers-a-small-but-mighty-problem/
[6] Bio4life. 2024. Compostable Self-Adhesive Materials. https://bio4life.nl/en/home-2/
[7] Jeong, Sarah. 2022. Fruit Stickers are the Scourge of the Compost Pile: When Everything Else Decays, those Little Plastic Stickers Remain. https://www.theverge.com/23022355/produce-stickers-fruit-plastic-compost-biodegradable

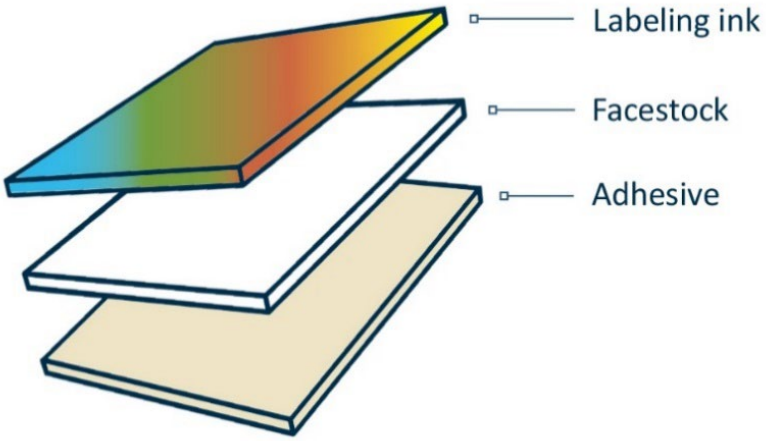

Figure 1 Layers of a produce sticker.

Compost facilities in Washington spend millions of dollars on compost feedstocks. Facilities such as Dirt Hugger (Dallesport) dedicate roughly 30 percent of their staff to contamination management.[8] This includes staff hand-sorting through feedstock materials and operating equipment such as screens and wind sifters.

Cedar Grove, another compost facility in Washington, developed their own specialty screening system known as the "kraken," featuring 26 suction points to vacuum contaminants.[9] Despite the range of rigorous methods used to remove plastic from feedstock, produce stickers are difficult to remove. Given their small size and adhesive nature, stickers will often roll up and drop through screens if detached from produce. They resist vacuuming or suction when still stuck to fruit peels, and they escape hand-sorting.[10] [11]

Because these plastic stickers are common in incoming compost feedstocks, they are likely to end up in finished compost.[12] As a result, the resale value of compost is significantly impacted. In some cases, batches are deemed wholly unmarketable, as "the price of compost directly corresponds to its cleanliness and quality."[13] For compost that is sold, its primary use is as a soil amendment. When compost containing plastic PLU stickers gets applied to soil, stickers enter the soil and then "degrade into smaller microplastic pieces."[14]

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[8] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[9] Personal communication with Jay Blazey, General Counsel, Cedar Grove. January 29, 2025.
[10] Personal communication with Jay Blazey, General Counsel, Cedar Grove. January 29, 2025.
[11] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[12] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[13] Closed Loop Partners, Composting Consortium. 2024. Don't Spoil the Soil: The Challenge of Contamination at Composting Sites. https://www.closedlooppartners.com/research/compostable-packaging-disintegration-at-composting-facilities/
[14] Grob, M., et al. 2024. Plastic Fruit Stickers in Industrial Composting – Surface and Structural Alterations Revealed by Electron Microscopy and Computed Tomography. https://pubs.acs.org/doi/10.1021/acs.est.3c08734

Microplastics (i.e., plastic debris smaller than 5 millimeters) harm environmental and human health. A recent toxicological study concludes that microplastics "modify ecosystems and levels of biodiversity by altering soil microbiota, structure and functions, as well as [creating] socio-economic impacts such as reduced agricultural yields and threats to regional fisheries."[15]

Microplastics can also have chemicals of concern like per- or polyfluoroalkyl substances (PFAS), a group of synthetic chemicals used in traditional and bio-plastic formulations.[16] PFAS are persistent pollutants in organisms and the environment with demonstrated toxicity as they build up in bodies over time.[17]

The American Society for Testing and Materials (ASTM) standards are changing to require that compostable plastics prohibit intentionally adding PFAS. Voluntary testing has already begun by the main certifying agencies in the United States: The Compost Manufacturing Alliance (CMA) and the Biodegradable Products Institute (BPI). Both CMA and BPI have added testing requirements for PFAS to their certification programs which go beyond the scope of what is required in the ASTM standards.[18]

On the other hand, there may be reasons to continue using conventional plastic produce stickers instead of transitioning to an alternative technology. These include unknowns about components of compostable plastic stickers and infrastructure needs. Such a change could lead to a more plastic-intensive alternative, like using plastic bags or wraps, which have different but significant impacts to the environment. The primary proposed alternative to current plastic PLU stickers include stickers made from compostable materials, laser printing on the produce, and ink-based printing on the produce.

A fundamental concern about any alternative is the scalability of new technologies such as laser and ink-based printing, and the ability to meet the needs of the domestic and international markets.

One key obstacle for compostable produce stickers is that bioplastics are not allowed in feedstocks for composts that are "approved for use on organic systems." Organic farms are a prime customer for compost, and the standards for compost approved use on organic farms are based on the feedstock materials used to make the compost, rather than the finished material itself. As compost for organic production is purchased at a premium price, limitations on sales to organic farms would be a disadvantage for composters. Feedstock standards for organic farms do not prohibit conventional plastic PLU stickers if they are under the acceptable limits of under five percent contamination by weight.[19]

Not allowing compostable products in compost feedstocks could create a barrier for composters who accept food waste and rely on the stronger price and market for compost that can be used on organic farms.[20] In 2024, BPI submitted a petition to the National Organic Program/United States Department of Agriculture (NOP/USDA) requesting the list of allowable inputs for organic agriculture be updated to

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[15] Ullah, F., et al. 2025. Toxicological Complexity of Microplastics in Terrestrial Ecosystems. https://www.sciencedirect.com/science/article/pii/S2589004225001397

[16] Beyond Plastics. 2024. Demystifying Compostable and Biodegradable Plastics: Do Safe and Sustainable Options Exist? https://www.beyondplastics.org/publications/demystifying-bioplastics

[17] Okamoto, K. 2022. CMA Policy on Fluorinated Chemicals in Food Service Packaging. Presented by CMA on March 30, 2022.

[18] Personal communication with Alyson Fick, Staff Manager, American Society for Testing and Materials. January 10, 2025.

[19] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.

[20] Personal communication with Jay Blazey, General Counsel, Cedar Grove. January 29, 2025.

include products that meet appropriate ASTM standards demonstrating industrial compostability, including produce stickers certified to ASTM D6400 or D6868.[21]

There are only a few manufacturers with market-ready compostable sticker options, including Sinclair Systems International (Sinclair), Elevate Packaging (Elevate), and Accu-Label. Only Sinclair offers a label that is certified compostable as a composite product. The others only have certain components that are certified compostable such as their facestock.[22] Accu-Label manufactures stickers with paper facestocks that meet composting requirements but are not certified due to the non-compostable adhesive.

A small manufacturing sector for compostable stickers may raise concerns about the availability and costs to people along the produce supply chain. However, legislative demands are driving the demand to develop compliant compostable sticker components, and new manufacturers may enter the market. New and existing manufacturers will be motivated to innovate and expand their product lines to meet increased market demand for compostable stickers. As a result, costs may also be reduced over time.

We discussed two additional technologies as potential alternatives to stickers: laser etching (i.e., using a low-intensity carbon dioxide laser to etch information directly onto the outer layer of produce)[23] and ink-based printing (using food-grade ink printed directly onto the peel).[24] Laser etching and ink printing have gained notoriety as labeling options that eliminate the use of outer packaging materials,[25] but they pose significant challenges for implementation at scale in Washington. Neither technology has existing infrastructure in the state nor shown that they can meet the labeling performance expected by the produce industry.

As a first step towards a comprehensive understanding of produce sticker technologies and their impacts on solid waste and compost systems, this section provides a background of relevant policies, key partners, and an overview of alternative technologies.

Policy and Regulatory Background

In 2022 and 2024, Washington passed HB 1799 and HB 2301, respectively. These bills are jointly referred to as the Organics Management Laws (OML). The OML established or amended more than 20 other state laws as a plan for managing organic materials in the state.[26] The CCA was passed in 2021 and focused on lowering state carbon emissions through limits and reduction goals.

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[21] Personal communication with Alexander Truelove, Legislation and Advocacy Manager, Biodegradable Products Institute (BPI). March 10, 2025.
[22] Sinclair Systems International. 2024. Industrial Compostable Fruit Labels. https://www.sinclair-intl.com/produce-labeling-solutions/industrial-compostable-labels/
[23] Code of Federal Regulations. 2012. 179.43 Carbon Dioxide Laser for Etching Food. https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-179/subpart-B/section-179.43
[24] Hakim, L. et. al. 2024. Edible Ink for Food Printing and Packaging Applications: A Review. https://pubs.rsc.org/en/content/articlelanding/2024/fb/d4fb00036f
[25] Kachook, Olga. 2021, May 12. Produce Stickers: Are they the Next Straw? Sustainable Packaging Coalition. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/ion
[26] https://apps.ecology.wa.gov/publications/documents/2307003.pdf

The OML complements the CCA by focusing reducing emissions, a greenhouse gas estimated to be around 30 times more potent than carbon dioxide.[27] A big source of methane is municipal landfills where organic waste breaks down and releases methane directly into the atmosphere. While some landfills have systems to capture methane, recycling organic waste into commodities like compost creates new economic opportunities. Thus, the OML seeks to take organic waste out of landfills with the goal of reducing organic landfill waste by 75 percent by the year 2030 and edible food disposed in landfills by 20 percent by 2025, both relative to 2015 levels.

While preventing and rescuing edible food is preferred, some food waste will always remain. The main alternative to diverting organic waste from landfills is compost, particularly via curbside collection and delivery to industrial composting facilities that can process large quantities of organics and produce a usable final product.

The OMLs affect many different groups, both public and private, and residential and commercial. Key parts of the OML build on local Solid Waste Management Plans (SWMPs). Each county and its respective cities develop SWMPs following the requirements in RCW 36.70A.142. Local plans provide a baseline for implementing statewide organic material waste management. Jurisdictions can develop their own programs or adopt the statewide Contamination and Reduction Outreach Plan (CROP).[28]

Comprehensive, coordinated, and economically viable markets must exist for compost services and compost products for the OML. The OML requirements roll out on a staggered timeline. Some are already in effect, while others will be phased in throughout the next ten years.

One requirement in the OML is for cities and counties to adopt Compost Procurement Ordinances (CPOs) when they "provide curbside collection of organic materials… or have a population greater than 25,000."[29] The CPOs encourage municipalities to buy finished compost from facilities and send an annual report detailing total tonnage of organic material collected and diverted from landfills, the facility/facilities used for processing collected materials, the "volume and cost of compost purchased made directly by the city, county, or [specific] contractors … [and] the source or sources of the compost purchased."[30]

Local procurement of compost could support a more robust and consistent market demand, leading to industrial facilities selling more finished products and creating more efficient ways to process more organics.

Under RCW 70A.205.545, Ecology sets geographic boundaries for the Business Organics Management Areas (BOMA) that are updated each July. A business in the BOMA that generates over certain thresholds of organic waste must subscribe to curbside collection services or self-manage their organic waste. As of January 1, 2024, businesses in the BOMA who create "at least 8 cubic yards of organic

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[27] University Corporation for Atmospheric Research. 2024. Some Greenhouse Gases are Stronger than Others. https://scied.ucar.edu/learning-zone/how-climate-works/some-greenhouse-gases-are-stronger-others

[28] Municipal Research and Services Center. 2024. Solid Waste Collection, Recycling and Disposal. https://mrsc.org/explore-topics/utilities/other-topics/solid-waste

[29] https://apps.ecology.wa.gov/publications/documents/2307003.pdf

[30] https://apps.ecology.wa.gov/publications/documents/2207026.pdf

material waste per week must arrange for organic materials management service." On January 1, 2025, the threshold decreased to four cubic yards of organic materials weekly for businesses in the BOMA, and it will drop again in 2026 to 96 gallons.[31]

The OML also requires local governments to site for additional organics management facilities under RCW 36.70A.142, as part of the plan to increase capacity for collecting and processing more organic material waste throughout the state.

By April 1, 2027, jurisdictions in the Organic Recycling Collection Areas (ORCA) will need to make source-separated organic materials collection available to "all residential customers except multifamily residences [and] non-residential customers that generate more than .25 cubic yards of organic waste per week. Cities and counties that provided organics collection service as of January 1, 2024, are not required to provide year-round service if they provide service at least 26 weeks annually."[32]

By April 1 of 2030, the organics collection service for any city in the ORCA must accept food waste. The jurisdiction must provide service to residents and businesses on a "nonelective basis" (aside from multifamily residences).

In addition to CPOs from cities and counties, the Compost Reimbursement Program (CRP) also tries to increase the purchase of finished compost for use in farming. Created in 2023, the CRP is a grant program operated through WSDA that works reimburses Washington farmers who apply finished compost from participating compost facilities. The CRP also studies how compost impacts the environment through soil quality and carbon storage.

Lastly, the Plastic Product Degradability Law sets uniform standards for products sold in Washington labeled as "compostable." As outlined in the Revised Code of Washington (RCW), "not all compost facilities and their associated processing technologies accept or are required to accept compostable packaging as feedstocks. However, implementing a standardized system and test methods may create the ability for them to take these products in the future."[33]

The law includes several standard specifications developed and tested by leading authorities on the degradability of plastic products commonly seen at municipal and industrial composting facilities. The standards include the ASTM (standards D6868, D6400, and D8410), the International Organization of Standardization (ISO 17088) and the European Union (EN13432).

In the first version of HB 2301, Section 502 banned plastic produce stickers or products that do not meet ASTM standards D6400 or D6868, effective by January 1, 2028.[34] During the hearing on January 23, 2024, testimony on the status of produce stickers led to removing this provision from the bill, and the direction that "Ecology must, in consultation with Agriculture, study and submit to the Legislature a

[31] https://apps.ecology.wa.gov/publications/SummaryPages/2407025.html
[32] https://apps.ecology.wa.gov/publications/documents/2407025.pdf
[33] Washington State Legislature. 2022. Plastic Product Degradability Law. https://app.leg.wa.gov/RCW/default.aspx?cite=70A.455.010
[34] Washington State Legislature. 2024. House Bill 2301, 68th Legislature, 2024 Regular Session. January 11. https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Bills/Housepercent20Bills/2301. pdf

status report on the compostability, performance, printability, and cost of produce sticker technologies by September 1, 2025."[35]

HB 2301, Section 401 states that: "The department of ecology, in consultation with the department of agriculture, must carry out a study and submit a brief summary report to the legislature by September 1, 2025, addressing the status of produce sticker technologies, including produce sticker options that do not contain plastic stickers or adhesives or that otherwise meet compostability standards."[36]

Testimony during the 2024 hearing identified the following considerations, which led to a report rather than a prohibition.

Speakers included:

- Biodegradable Products Institute – Certifying Agency
- Compost Manufacturers Association – Certifying Agency
- Envirovate Materials – Adhesive Manufacturer
- Northwest Grocery Association (mentioned by proxy by Washington Food Industry Association)
- Sinclair International – Sticker Manufacturer
- Washington Food Industry Association – Retailer Association
- Washington Organics Recycling Council – Council of Recycling Agencies
- Washington Potato and Onion Association – Non-Profit Industry Resource

Key points that led to the removal of compostable sticker requirements from HB 2301 and led to the recommendation for this study:

Stickers are an important part of retail business. They provide key information about pricing and the produce source, and retail stores cannot have stickers falling off products. (Washington Food Industry Association and Northwest Grocery Association)

Stickers will be replaced by other trends like bagging, which will further increase the footprint of more packaging material, whether it is plastic, or a compostable product. PLU labels have a small packaging footprint within the supply chain. (Sinclair International)

Plastic produce stickers are problematic for compost manufacturers and are impacting their ability to make a clean marketable compost product. (Washington Organics Recycling Council and Compost Manufacturers Association)

Compostable sticker options on the market do not fully meet efficiency, quality, and cost needs of global customers. (Sinclair International)

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[35] Washington State Legislature. 2024. Final Bill Report E2SHB 2301 C 341 L 24—Synopsis as Enacted. June 6. https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Billpercent20Reports/House/2301-S2.Epercent20HBRpercent20FBRpercent2024.pdf

[36] Washington State Legislature. 2024. Engrossed Second Substitute House Bill 2301. https://lawfilesext.leg.wa.gov/biennium/2023-24/Pdf/Bills/Housepercent20Passedpercent20Legislature/2301-S2.PL.pdf

International compost standards are critical. International trade is a key to Washington growers and many export to Asia, Canada and Europe. These countries reference international standards instead of ASTM standards used in the US. (Sinclair International)

Global collaborators including the European Union, Canada, Australia and New Zealand are developing global standards for compostable stickers, which will be different from the ASTM standards D6400 and D6868. These forces can impact trade in and out of the state. Washington should join other jurisdictions globally that are banning plastic stickers and considering alternatives. (Compost Manufacturers Association)

Standards for composting are very similar for biodegradation and disintegration across the world, but allowances for trace elements are very different. (Sinclair International)

There are ASTM-compliant compostable stickers and paper-based stickers that have demonstrated full disintegration in real-world composting systems. (BPI and CMA)

Agriculture stakeholders were not considered. There needs to be more discussion on this bill with input from agriculture. (Washington Potato and Onion Association)

More time is needed to meet food quality adhesive standards and have stickers adhere to fruit at least 95 percent of the time. The challenge with compostable options is the adhesive. (Sinclair International and Envirovate Materials)

Some materials that are exempt from testing or certification can contain harmful trace elements like PFAS and adhesives that make up to 30 percent of the label content. All labels should meet the same composting standards to help keep harmful materials out and retain compost quality. (Biodegradable Products Institute and Sinclair International)

New designs and changes at different levels will affect many parties in the state, and they will need more information. The next section summarizes the key partners that could be affected by restrictions on plastic produce stickers.

Key Partners

The world of produce stickers in Washington is complex. There are many roles at both governance and implementation levels. Decisions that affect sticker technologies in Washington will impact groups differently depending on their role. Below is a discussion of these roles and how they may be impacted.

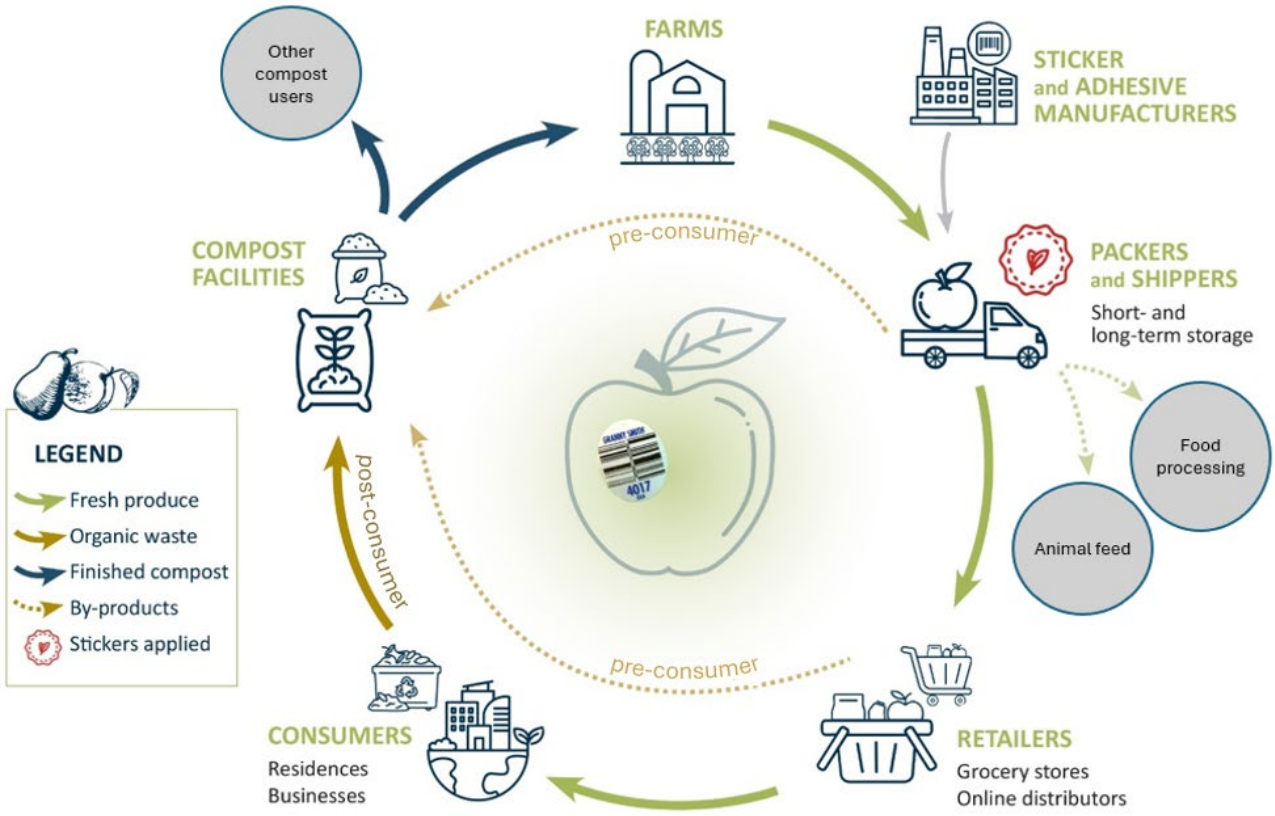

Figure 2 Flow of produce labeled with PLU stickers.

Figure 2 outlines the flow of produce that gets labeled with PLU stickers through different groups in Washington, from farm to compost facility. Given that apples are the most economically important item in Washington to go through this cycle, we use them as a case study to explain the process in Figure 2, beginning at "Farms" and moving clockwise. The process described here is largely applicable to pears as well.

Apples grow on "Farms" (Figure 2) where they are harvested and packed directly into bins. The average bin holds around 800 pounds of fruit. These bins are taken to "Packers and Shippers" (Figure 2) at packing warehouses where bins go into cold storage (at roughly 34°F). Apples are unloaded to be washed and waxed, then placed in cold storage once more. Some apples go directly from cold storage to packing lines, while "higher quality" apples are put in controlled atmosphere storage—a special type of cold storage with low oxygen that preserves freshness for extended periods of time.[37] [38]

Apples with visible defects are unsuitable for fresh produce retail. Staff at packing houses pull them and put them in cold storage to an alternative use. Pulled apples that are unsuitable for any commercial use

[37] Graziano, J. and M. Farcuh. 2021. Controlled Atmosphere Storage of Apples. https://extension.umd.edu/resource/controlled-atmosphere-storage-apples/

[38] Personal communication with Robert Newell, Fruit and Vegetable Program Manager, Washington State Department of Agriculture. March 7, 2025.

go into the organic waste stream and are sent to "Compost Facilities" (Figure 2) as pre-consumer food waste. Blemished apples may still be useful for use as either "Cattle Feed" or in "Food Processing" (Figure 2). Apples for food processing are assessed to see if they are juice grade, slice grade, or peel grade, and get distributed accordingly.[39]

Unless blemished apples are pulled before they go to a packing line, they will get a sticker that could potentially end up at a compost facility.

Apples sold fresh at retail are packed for specific orders and immediately shipped once filled (known as "commit to pack"), or they are packed and put in short-term cold storage to wait (up to six months) until someone orders them.[40]After going to "Retailers" like grocery stores and online distributors (Figure 2), apples that are not used or sold go to "Compost Facilities" as more pre-consumer food waste.

Retailers sell apples to customers ("Residences and Businesses" in Figure 2). Some apples enter the organic waste stream as post-consumer food waste and are taken to "Compost Facilities." The organic waste from both pre- and post-consumer sources is used at compost facilities as feedstock to make compost.

The finished compost is sold as a commercial product, usually used on "Farms" (Figure 2) or other land application like landscaping, construction, and home gardening, etc.[41]

Most crops follow a similar cycle as apples. Only a small percentage of onions sold as fresh produce are labeled with stickers, and this process is slightly different. Onions brought in from "Farms" to "Packers and Shippers" are largely loaded directly onto packing lines, while those that are not, are placed in large storage rooms (not cold storage) to eventually be pulled for packing. Once labeled, onions are packed as loose produce (rather than trays) directly into boxes of a certain weight, with most packed for "commit to pack" orders and shipped immediately to "Retailers".[42]

Potatoes labeled with produce stickers follow this process as well. However, potatoes are wet during packing, which makes adhesion difficult. While occasional, it is uncommon for most bulk potatoes to be labeled with produce stickers.[43]

Washington State Department of Ecology

Ecology is the environmental regulatory agency for Washington. It is the primary authority who assists implementing the requirements in the Organics Management Laws (OML). The OML, as previously discussed, is the central legislation governing compost and organic waste management in Washington. Ecology needs more data and information about compostable products like produce

[39] Personal communication with Mikey Hanks, Operations Manager, Washington Fruit and Produce Co. February 20, 2025.
[40] Personal communication with Robert Newell, Fruit and Vegetable Program Manager, Washington State Department of Agriculture. March 7, 2025.
[41] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[42] Personal communication with Robert Newell, Fruit and Vegetable Program Manager, Washington State Department of Agriculture. March 14, 2025.
[43]Personal communication with Matthew Harris, Director of Government Affairs and Assistant Executive Director, Washington State Potato Commission. December 30, 2024.

stickers to adequately support and advise local governments, waste collection providers, and organics management facilities including composters.

Ecology establishes minimum standards for managing solid and organic waste, enforces compostable labeling standards, and oversees various programs and requirements as part of the OML. This includes annually publishing the BOMA and ensuring compliance with CPO reporting by required jurisdictions.[44]

Washington State Department of Agriculture (WSDA)

The Washington Department of Agriculture (WSDA) is the regulating agency for Washington farms. They are a government authority on behalf of the state and an advocate on behalf of members of the industry. The Department relates to the issues of produce stickers and compost in several different capacities.

As an agency responsible for maintaining food safety standards, WSDA oversees the production, packing, and distribution of agricultural products. Produce stickers are extremely helpful to WSDA when the ability to track items is critical, such as during a food safety recall. The stickers can communicate vital information such as origin, variety, volume, and price. In its regulatory capacity, WSDA also supports Ecology in the process of approving SWMPs under the OML, reviewing preliminary drafts, and advising local jurisdictions and Ecology on matters of insect pests and plant diseases like the apple maggot quarantine.[45]

Lastly, WSDA also runs the state Compost Reimbursement Program. The CRP works with Washington farmers to incentivize the use of finished compost in commercial agricultural operations and facilitates research on the impact of compost on soil quality (through samples from participating farms).[46]

Produce farmers, packers, and distributors

Within Washington's thriving agricultural industry, there exists a broad range of operations. Activities vary in type and scale, with people working to grow, pack, and distribute over 300 different crops. Washington leads US production in tree fruits like apples, pears, and cherries. According to WSDA, Washington is responsible for roughly 70 percent of the total apple production in the United States, grossing nearly $2 billion in 2023.[47]

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[44] https://apps.ecology.wa.gov/publications/SummaryPages/2407025.html

[45] Washington State Legislature. 2024. RCW 70A.205.060 County and City Comprehensive Solid Waste Management Plans—Review by Department of Agriculture. https://app.leg.wa.gov/RCW/default.aspx?cite=70A.205.060

[46] Washington State Department of Agriculture. 2024. What is the Carbon Reimbursement Program? Available here.

[47] Washington State Department of Agriculture. 2024. Agriculture: A Cornerstone of Washington's Economy. https://agr.wa.gov/departments/land-and-water/natural-resources/soil-health/compost-reimbursement

Washington has just shy of 14 million acres across the state dedicated to agriculture, with roughly 32,000 farms operating independently.[48] This includes large-scale, multifaceted entities like Washington Fruit and Produce Co. Wahington Fruit and Produce is a Yakima-based organization that grows, packs, and ships produce in partnership with several other Washington agricultural subsidiaries (including Mount Adams Fruit, Roche Fruit, and Gilbert Orchards). Altogether they span thousands of acres.[49] Washington also has many small, family-owned and operated outfits that grow on just part of an acre.[50]

All farms must comply with the WSDA food-safety laws that govern the entire supply chain from harvest to grocery checkout.[51] Produce stickers play a major role in streamlining the process and ensuring all parties are informed of what produce they are handling, where it came from, and, in the case of organic produce, how it was grown. Aside from produce stickers, plastic or gusset bags are another packing method used for Washington produce.

In fall 2023, the majority (69.4 percent) of Washington apples were labeled with produce stickers and packed in bulk trays, while the rest (30.6 percent) was bagged. Retailer demand for bagged produce increased significantly during the COVID-19 pandemic, as consumers viewed bagged produce as safer (not handled by other customers) and curbside pickup/delivery services became more prominent (standard bags being more convenient than loose bulk produce). Demand has stayed relatively consistent since then.[52]

In Washington, apples and pears are the primary fresh produce items labeled with produce stickers. Other items like onions, stone fruits (e.g. peaches, nectarines), and occasionally potatoes also get stickers. Most of the produce in the state labeled with stickers is sent by growers to be packed and sold at larger packing warehouses, a system referred to as consignment. There are roughly 95 to 100 packing warehouses labeling produce in the state, plus smaller operations like roadside fruit stands. Larger operations typically label about 6 million 40-pound boxes worth of produce annually, while smaller operations label around 1 to 2 million.[53]

Packing houses primarily use on-line labeling equipment,[54] where lanes holding single items of produce are run on conveyor belts under applicators that stick labels directly onto items as they pass.

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[48] United States Department of Agriculture, National Agricultural Statistics Service. 2023. 2023 State Agricultural Review: Washington. https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=WASHINGTON
[49] Roche Fruit. 2024. Our Company. https://rochefruit.com/our-company
[50] New Heritage Farms. 2024. About Us. https://www.newheritagemarketgarden.com/about-us
[51] Washington State Department of Agriculture. 2024. Food Safety Program. https://agr.wa.gov/departments/food-safety/food-safety
[52] Personal communication with Jon Devaney, President, Washington State Tree Fruit Association. February 19, 2025.
[53] Personal communication with Robert Newell, Fruit and Vegetable Program Manager, Washington State Department of Agriculture. March 7, 2025.
[54] Personal communication with Keith Mathews, Program Coordinator, Yakima County Horticultural Pest and Disease Board. February 13, 2025.

Compostable product certifiers and groups setting scientific standards

The process to certify compostable products, including produce stickers, is multi-staged and involves a variety of third-party actors. This section addresses key United States stakeholders in this arena. Each organization's processes and protocols are described that contribute to the creation of compost standards and certifying compostable produce stickers.

American Society for Testing and Materials (ASTM)

The ASTM develops compost standards used in the United States. They do not enforce regulations, conduct audits, or test products. Instead, they create the standards of compostability to which products in the United States must comply to be certified as compostable. The organization is composed of dedicated staff and members from a range of industries working within and across subject-specific committees to develop over 12,800 standards currently published.[55]

There are a broad range of committees and subcommittees related to the different industries and products for which ASTM develops standards. Compostable products are just one subject across many that ASTM works with. Anyone on the membership roster can join any committee and have a technical voice contributing to proposals for creating or changing standards. There are two key areas of standards development: subcommittees and main committees.

Subcommittees include niche-level experts on specific topics within the subject area of a main committee. Members have specialized topics or issues they would like to see addressed. Subcommittee D20.96 (Environmentally Degradable and Biobased Products) works on compostable produce stickers. They are under the main committee D20 (Plastics).[56]

When subcommittees work through an issue and develop a standard to address it, that standard is put forward as a ballot (or proposal to be voted on) to the main committee. All subcommittees review the standard and vote. If successful, the ballot is then proposed to all members of ASTM and, if approved, is published as an official standard. All ASTM standards are living documents. They can be reopened and reviewed for amendment at any time, like when new technology evolves and necessitates updates. In addition, standards are formally reviewed for revision or re-approval every five year. The ASTM edits or re-approves every standard within eight years or else it is withdrawn.[57] This keeps standards relevant to the industries and conditions in which they are applied.

The ASTM does not write standards for specific products. However, D6400 and D6868 were developed by subcommittee D20.96 and are relevant to produce stickers. Both look at items that claim to be compostable in industrial settings, but D6400 addresses single-layer items, and

[55] American Society for Testing and Materials. 2025. Standards and Publications. https://www.astm.org/standards-and-solutions/standards-publications

[56] American Society for Testing and Materials. 2025. Committee D20 Subcommittees. https://www.astm.org/membership-participation/technical-committees/committee-d20/subcommittee-d20

[57] Personal communication with Alyson Fick, Staff Manager, American Society for Testing and Materials. January 7, 2025.

D6868 addresses multi-layer products where bioplastics or polymers are used as coatings on compostable substrates.

Compostability standards look at four categories of product composition and performance: characterization (levels of heavy metals and regulated elements), biodegradation (breakdown into natural elements), disintegration (breakdown into certain sized particulates), and ecotoxicity (effect on plant health). The ASTM standards outline testing specifications, certain parameters, and results that must be met for an item to be called compostable, but ASTM does not outline testing methods themselves. Testing methods are selected at the discretion of the lab conducting them, so long as they are compliant with ASTM specifications.[58]

With their committee consensus structure, third-part certifiers can modify requirements from ASTM standards through a peer review and approval process. This typically adds criteria. For example, to limit the presence of PFAS in compostable products, the main certifiers in the United States (Biodegradable Products Institute and Compost Manufacturing Alliance) have added testing requirements and standards for total PFAS. They do this by adding a test of total fluorine (TF), which must be less than 100ppm, to their certification programs. This goes beyond the current scope of ASTM standards D6400 and D6868.[59]

Biodegradable Products Institute (BPI)

A non-profit certifier for compostable products in North America, BPI verifies products meet ASTM standards. As a certifier, BPI does not test products but collects and analyzes data provided by accredited testing facilities. The lab results ensure compliance with ASTM, then BPI provides certification to products accordingly. BPI only uses lab testing to verify a product's compostability. They do not believe any existing field-testing methods are sufficiently developed or restrictive to produce reliable results.

Staff at BPI have shared that field testing shows whether compost facilities have the right conditions for compostable products to break down instead of confirming the compostability of a product. As a member of ASTM and the D20.96 subcommittee, BPI participates in processes to define field test methods for compostable plastics. Field testing still needs standardizing for how a test runs and the appropriate conditions.[60]

For BPI to certify a produce sticker, it must meet several criteria:

- Be associated with desirable organic wastes such as food scraps (applicable for any fresh produce sticker).
- Not a compostable redesign of items that are better suited for recycling (e.g. water bottle).
- Does not need disassembly or deconstruction to be composted.

[58] Personal communication with Kelvin Okamoto, Chair of the D20.96: Environmentally Degradable and Biobased Products Subcommittee, ASTM. February 7, 2025.
[59] Personal communication with Alyson Fick, Staff Manager, American Society for Testing and Materials. January 10, 2025.
[60] Alexander Truelove, Legislation and Advocacy Manager, Biodegradable Products Institute. January 7, 2025.

- Meet BPI artwork requirements.[61]

After completing BPI's application, label manufacturers send one sample of their product to a third-party laboratory accredited by BPI for ASTM compliance testing. Another identical sample goes to DIN CERTO, a group BPI uses for technical review, to be verified as a valid sample. Depending on its design, a sticker is tested by the laboratory for compliance with either ASTM standard D6400 or D6868. It must also show Total Fluorine content less than 100ppm (parts per million) as a measure for controlling the presence of PFAS.

Labs send the results to BPI and DIN CERTCO for their assessment. If DIN CERTO concludes the product fully compliant, the artwork undergoes a comprehensive review by BPI, while manufacturers finish paperwork. When complete, the sticker will be officially certified and listed in BPI's online catalog. Certification is valid for three years. A manufacturer must recertify the product to retain the BPI product seal and online listing every three years.[62]

Compost Manufacturing Alliance (CMA)

The CMA is a Washington organization that provides third-party certification services for compostable products both in the US and abroad. The Alliance came from Washington compost facility Cedar Grove after they developed a compostable products field-testing program in 2007. The goal was to create lists of compostables accepted by the facility to share with municipal partners and customers.

The program grew over the next decade and earned national recognition as a standard of compostability in municipal facilities across the United States. In 2017, Cedar Grove and six partners came together to form CMA and expanded field testing operations to other large composting facilities across the country.[63]

They are also a member of ASTM and sits on the D20.96 subcommittee as well as Committee D34 on Waste Management. On the subcommittee, CMA has put forth a vote for their mesh bag method – a field test for compostable products - to make a new or add to the published standard for compostable plastics.

The certification process at CMA mirrors BPI's in many ways, but they diverge in several key areas. Like BPI, eligible products for CMA certification must be related to desirable organic waste including yard or food waste.[64] After the application is completed, the product must go through several types of testing to demonstrate compliance with ASTM and CMA standards in two main categories: lab and field.

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[61] Biodegradable Products Institute. 2025. Before You Start: Is My Product, Package, or Material Eligible for BPI Certification? https://bpiworld.org/before-you-start

[62] Personal communication with Margaret Eldridge, Certification Director, Biodegradable Products Institute. February 13, 2025.

[63] Compost Manufacturing Alliance. 2025. What is CMA? https://compostmanufacturingalliance.com/what-is-cma/

[64] Compost Manufacturing Alliance. 2025. Certification and Acceptance Requirements. https://compostmanufacturingalliance.com/certification-and-acceptance-requirements/

Lab testing confirms that a product meets ASTM standards (either D6400 or D6868 depending on sticker structure) and is below the maximum TF content. For certification, manufacturers send sticker samples to two laboratories approved by CMA. One laboratory tests the product meets ASTM standards (either D6400 or D6868 depending on label structure). The other lab tests for PFAS standard. The CMA sets a TF limit of less than 100ppm.

Fluorine testing methods are complex and rigorous to get accurate results, so CMA requires an additional level of lab verification. [65] The CMA accredits labs that test for TF testing laboratories specifically for this purpose.

For field testing, the manufacturer sends a sample to CMA, who tests the sticker at an official field site (an industrial composting facility) using the mesh bag method. Conditions and processing methods at field sites vary and so do results. Extensive data gathered from across sites with different processing methods provides reliable information for comparison. Experts at CMA review the field-testing and lab results. After paperwork is complete, the sticker is officially certified and listed on CMA's "accepted products list" for three years.

CMA has another acceptance program for products that cannot be certified but comply with CMA's "Substrate Review." The substrate review verifies that certain components of a product (e.g. sticker facestock) are compostable, when other components are not. As part of CMA's "plastic elimination strategy," these products are also listed on the CMA "accepted products list." Listing them promotes their use even though they do not meet ASTM standards. CMA describes these products as "harm reduction" for composters and serve as alternatives to products with more plastic.

Paper stickers fall into this category. Companies like Accu-Label make paper fruit stickers that have a non-compostable adhesive. The CMA acceptance program allows them to approve stickers with a paper facestock that disintegrate well and promote their use while technology develops to make compostable adhesives more available. This is an example of a phased approach to compostables: CMA is using their influence to decrease traditional plastics while the industry progresses. Developing technology like more compostable adhesives will eventually make fully compostable stickers more feasible.[66]

Sticker and adhesive makers

Proprietary considerations did not allow Greene Economics to get market share information. A small number of sticker and adhesive producers serve the global produce market. In Washington, sources said there are two primary suppliers for fruit packing houses in Washington, but no one gave their names.[67]

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[65] Okamoto, K. 2022. CMA Policy on Fluorinated Chemicals in Food Service Packaging. Presented at a CMA Webinar, March 30, 2022.

[66] Personal communication with Janet Thoman, Compliance Director, Compost Manufacturing Alliance. February 5, 2025.

[67] Personal communication with Robert Newell, Fruit and Vegetable Program Manager, Washington State Department of Agriculture. March 7, 2025.

Three companies lead the production of compostable produce stickers: Sinclair, Elevate, and Accu-Label. Both Sinclair and Accu-Label use a vertically integrated business model, wherein all means of production (raw materials, stickers, and equipment) are manufactured within their organizations.[68] [69] [70] Elevate sources its stickers and materials from a third-party (details below).

Sinclair

Sinclair has supplied PLU stickers for a long time. They make both conventional plastic and compostable food-safe stickers.[71] Sinclair was the first company to create a compostable produce label certified under European industrial compost standard EN 13432. Sinclair's T55 label, its biggest seller, is sold primarily in Europe and South Africa.[72] The T55 is certified as industrially compostable under EN 13432 by TUV Austria and meets the ecotoxicity criteria required by Australian standards AS 4736. Both standards are comparable to ASTM D6400 and D6868 in most areas. Europe's EN 13432 is the strictest among global standards for thresholds of trace elements. Australia's AS 4736 requires worm testing as an additional test while other standards do not (see Table 1). Sinclair offers full-service options for fruit stickers including designing, printing, or leasing their application. [73]

Accu-Label

Accu-Label is a subsidiary of equipment company Ag-Tronic Control Systems. They supply adhesive produce stickers in the United States and only offer paper-based sticker options. The paper facestock meets all criteria of compostability under ASTM standards and PFAS limits, but the sticker cannot be certified due to its non-compostable adhesive. The adhesive does not fully break down within certification timeframes.[74] While their stickers are not certified, the CMA promotes their use through the Substrate Review and acceptance program. This designation serves helps Accu-Label provide paper-based alternatives to plastic stickers while the technology develops.[75]

Elevate

Elevate is a compostable packaging company based in the U.S. They specialize in custom printed labels that are certified compostable. Each part of the sticker is independently certified. Elevate

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[68] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[69] Personal communication with Derek Sorrel, Quality and Sustainability Manger, Accu-Label. February 10, 2025.
[70] Personal communication with Rich Cohen, Chief Executive Officer, Elevate Packaging. March 4, 2025.
[71] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[72] Sinclair Systems International. 2025. Industrial Compostable Fruit Labels. https://www.sinclair-intl.com/produce-labeling-solutions/industrial-compostable-labels/
[73] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[74] Personal communication with Derek Sorrell, Quality and Sustainability Manager, Accu-Label. February 10, 2025.
[75] Personal communication with Janet Thoman, Compliance Director, Compost Manufacturing Alliance. February 5, 2025.

has several different options for facestock materials that can be used for produce stickers (see Table 1), and all are certified to ASTM D6400 and EN 13432 standards. In 2015, Elevate consolidated with Bio4life, a European company that made the world's first compostable adhesive under the brand name BioTAK. Bio4life has exclusive rights to what currently remains as the world's only certified compostable adhesive. Produce are a small part of Elevate's sales. CEO Rich Cohen says fruit and vegetable packers work on such tight margins that they are unlikely to use a more expensive labeling option unless pushed by legislation. Elevate does not currently have any presence in Washington as a sticker supplier.[76]

Sticker and manufacturer summary

Right now, Elevate is one of the only global manufacturers that can supply a certified compostable option and the only one with access to a fully compostable adhesive. Sinclair also has certified options. The market for compostable stickers is limited by low access to compostable adhesives. Some believe the market is also nascent, as compostable products have only recently gained popularity. Global requirements for compostable stickers are spurring businesses to come in and out of the market. Many anticipate a competitive race to develop compostable adhesives and fully compostable stickers as the market breaks open with international legislation mandating their use.

Table 1: Summary of current non-plastic fruit stick options

Manufacturer	Facestock Material	Industrially Compostable?	Certification
Sinclair	Compostable film	Yes	EN 13432 OK Compost Home OK Compost Industrial AS 5810
Elevate Packaging	Paper Cellulose Film PLA (bioplastic) Biopolymer	Yes	EN 13432 ASTM D6400
Accu-Label	Paper	No	CMA "accepted"

Table 1 A summary of current options for produce stickers that do not use or use less plastic than traditional fruit stickers.

Washington Compost Facility Operators

Washington has 58 active compost facilities in 28 counties. The Northwest and Southwest regions, where population is densest, have more facilities, since there is more organic materials to use as a feedstock.[77] In 2022 to 2023, about 897,700 tons of organic waste was collected from residential

[76] Personal communication with Rich Cohen, CEO, Elevate Packaging. March 4, 2025.
[77] Zero Waste Washington. 2021. Improving Organic Materials Management in Washington State. https://zerowastewashington.org/wp-content/uploads/2021/05/WA-Organic-Waste-Mgmt_Zero-Waste-WA-May-2021.pdf

and commercial customers in Washington. Most organic waste comes from residential sources (71 percent), with the rest (29 percent) coming from businesses. Although this ratio changes from region to region.[78]

The are two main categories of residential organic waste: yard waste and food waste. Food waste has higher rates of contamination compared to yard debris due to the presence of food adjacent plastic. Common contaminants at compost facilities include rigid plastic take out containers, film plastic bags, wraps and pouches, and plastic lined paper (cups and food containers).[79] Most (89.6 percent) organic waste is deemed "Widely Accepted Compostable". This comes from compost facilities who assess organic waste for contamination.

The remaining 10.4 percent of organic waste is considered unacceptable for further processing, often due to contamination. Both compost facilities and local governments have concerns about contamination as the OML takes effect. Collecting more residential organic waste successfully will require careful sorting to avoid making residential food waste a liability.[80]

Compost and other organic waste management facilities in Washington vary widely in “processing methods, times, and conditions, as well as their ability to accept food waste and compostable products.”[81] While food adjacent products can be certified as compostable under standards like ASTM D6400, D6868 or EN 13432, not all organic waste facilities can take these products. If the facility has different conditions than the ones used to test the product in a lab, the product and its components may not break down.

Facilities that accept products certified compostable products are concentrated in western Washington, so access to such services can vary by region.[82] Washington compost facilities say the largest barrier to accepting compostable products is “greenwashing,” or products that misrepresent themselves as compostable to consumers. Lookalike products contaminate facilities.[83] The other barrier to accepting compostable products is that many of them do not fully disintegrate within the facility’s processing time. The products, whether stickers or utensils, create visual contamination in the finished compost.[84] Confirming that materials break down in an industrial facility is critical to optimizing compostable plastics.[85]

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[78] https://apps.ecology.wa.gov/publications/documents/2407007.pdf

[79] Composting Consortium. 2024. Don’t Spoil the Soil: The Challenge of Contamination at Composting Sites. https://www.closedlooppartners.com/composting-consortium-reveals-contamination-rates/

[80] Association of Washington Cities. 2024. Costly Changes Proposed to New Organics Management Law. January 21. https://wacities.org/news/2024/03/08/costly-changes-proposed-to-new-organics-management-law

[81] https://apps.ecology.wa.gov/publications/SummaryPages/2407028.html

[82] https://apps.ecology.wa.gov/publications/documents/2407007.pdf

[83] https://apps.ecology.wa.gov/publications/SummaryPages/2307022.html

[84] https://apps.ecology.wa.gov/publications/documents/2307021.pdf

[85] WasteMINZ – New Zealand. 2023. It's Complicated: A Guide to Biodegradable and Compostable Plastic Products and Packaging. https://www.plastics.org.nz/images/documents/Environment/Compostables/Its-complicated-guide-Final-2019.pdf

Facilities differ in their budgets and capabilities to manage contamination in feedstocks. The average compost facility spends 21 percent of their operating budget on contamination removal.[86] However, these costs do not apply to removing fruit stickers. Stickers are too difficult for staff to pick out by hand, and they resist vacuums and wind-sifters when stuck to peels.[87] Even when detached, stickers roll up and fall through sorting screens. As a result, the stickers continue through the process and end up in the finished product.[88, 89]

Washington compost producers experience contamination from plastic fruit stickers and other products more than any other group. This is because plastic stickers end up in finished compost even when compostable products are certified, since compostable products break down differently depending on the facility. All of this has impacts on the quality and market value of the finished compost.

Organic farmers are a key market for compost producers. Feedstock contamination from materials that are prohibited under the National Organic Program (including compostable plastics) can jeopardize a composter's ability to sell product for use on organic farms. For composters that want to make and sell compost for organic farmers, produce stickers present a unique challenge. Given that compost is considered an agricultural input, the compost itself does not get "certified organic." Organic certification is for products only.

For inputs, the Organic Materials Review Institute (OMRI) approves inputs to use in organic farming. This is the main agency used by professionals, since OMRI verifies that a product meets NOP guidelines. To be used on organic farms, compost feedstocks must meet the NOP guidelines. A facility must list all their feedstocks and where they come from when having compost reviewed by a group like OMRI.

Facilities applying for OMRI approval need to outline their methods to remove and/or prevent any prohibited material when dealing with high-risk feedstocks like post-consumer food waste and municipal green waste. Under the list of prohibited materials requiring a removal or prevention plan are compostable products: "synthetic substances not listed as allowed by the national [organic] standards, such as treated and painted wood, particleboard, gypsum board, plastics, biodegradable plastics, [etc.]."[90] This would include compostable produce stickers.

Plastic (i.e., non-compostable) produce stickers are contaminants within the same high-risk waste streams, but they do not require a plan for removal or prevention. Therefore, current regulations allow the presence of plastic produce stickers in feedstocks for compost to be used on organic farms. However, compostable stickers require a plan for removal or prevention, they but are

[86] Composting Consortium. 2024. Don't Spoil the Soil: The Challenge of Contamination at Composting Sites. https://www.closedlooppartners.com/composting-consortium-reveals-contamination-rates/
[87] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. January 4, 2025.
[88] Personal communication with Jay Blazey, General Counsel, Cedar Grove. January 29, 2025.
[89] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[90] Personal communication with Doug Currier, Technical Director, Organic Materials Review Institute. February 14, 2025.

virtually impossible to sort out of feedstocks. A transition to compostable stickers may cause concerns for facilities trying to make compost that can be sold to organic farmers.

If Washington mandated compostable stickers and NOP guidelines stayed the same, composters that want to sell to organic farms would face a dilemma - either stop accepting post-consumer food waste that could contain this material, or compost high-risk waste streams separately to reduce the chance of compostable stickers being used in compost approved for organic farming.[91]

Other places with restrictions on plastic fruit stickers

Legislative actions to ban or restrict non-compostable produce stickers have been proposed or passed at local, state, and international levels (see Table 2). France was the first to ban selling produce labeled with non-compostable stickers as of January 1, 2022. New Zealand followed with a ban on non-compostable stickers effective July 1, 2023, including a ban on non-compostable adhesives in 2025.[92] The New Zealand law has since been edited to require home compostable facestock on stickers for domestic produce by 2028 (extended from the original 2025 deadline). Certified home compostable stickers under Australian standards are required for imported produce by 2028.

South Australia is set to follow with a ban on plastic produce stickers effective in 2025. Many hope the Australian government will work across its local and territorial governments to create national regulations.[93] Starting in September 2025, South Australia will accept PLU labels certified to any compost standard (home or industrial) until 2028. After 2028, the law requires stickers be entirely compostable under Australian standards (AS 4736 and AS 5810).[94]

An international summit was held in Niagara Falls, Canada on October 1, 2024. It included leaders across the produce, compost, and sticker manufacturing industries. They discussed the development and establishment of global standards on compostability for fruit stickers.

The Canadian Produce Marketing Association (CPMA) and Compost Council of Canada (CCC) organized the event. Attendees included International Fresh Produce Standards (IFPS), International Compost Alliance (ICA), USDA, and representatives from Australia, New Zealand, the United States, Ireland, the United Kingdom, Italy, and other members of the EU.

The outcomes of the meeting included the initial steps in adopting global standards for compostable fruit stickers and a roadmap for moving forward with greater involvement from governments and

[91] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.
[92] New Zealand Ministry for the Environment. 2023. Aotearoa New Zealand Single-Use Plastics Ban: 2023 Guide for Businesses. https://swdc.govt.nz/wp-content/uploads/NZ-plastics-ban-guide-for-business-factsheet.pdf
[93] Government of South Australia: Replace the Waste. 2024. Legislation Explained. https://www.replacethewaste.sa.gov.au/legislation-explained
[94] Government of South Australia: Replace the Waste. 2024. Guide to the 2025 Ban on Single-Use Plastics. https://www.replacethewaste.sa.gov.au/guideline-2025-bans

industry representatives. The goal is to solidify and adopt worldwide regulations.[95] The ongoing work is now focused on finalizing the details of the global standards for compostable fruit stickers.

Sub-committees from the meeting continued to work in the following months, and the group came back together in March 2025. They are still working to communicate information about the initiative and specifics of the standard. The FAQs, technical presentations, and other materials were presented at the March 2025 meeting to help individual countries reach out to their key partner groups.[96]

Legislative mandates drive the timeline for the initiative around international standards for compostable fruit stickers with 2028 being the target deadline. Originally introduced in December 2022, the EU's Packaging and Packaging Waste Reduction Act (PPWR) was signed on December 16, 2024, and took effect on February 11, 2025.

The PPWR is a wide-sweeping set of regulations aiming to reduce harmful packaging waste and promote the use of sustainable packaging across industries from design to disposal. The goal is to lower greenhouse gas emissions and water use as a result.[97] Article 9 of the PPWR addresses produce stickers. By February 12, 2028, "sticky labels affixed to fruit and vegetables shall be compatible with the standard for composting in industrially controlled conditions in bio-waste treatment facilities and shall be compatible, where required by Member States, with home-composting standards."[98]

As seen with the amendments to legislation in South Australia and New Zealand, global action around compostable produce stickers has increasingly aligned with the EU 2028 deadline.

The U.S. Plastics Pact lists non-compostable produce stickers as a "Problematic and Unnecessary Material." Items on this list are plastic packaging items, components, or materials that should be avoided through elimination, reuse or replacement. It also includes items that commonly do not get composted or recycled after use and items that are detrimental to recycling or composting systems due to their format, composition, or size.[99] As a result, states like Washington and New York have proposed legislative actions that would replace non-compostable PLU produce stickers.

New York State introduced a bill in January 2025 proposing a ban on non-compostable produce stickers that would start in 2026. Current inventory of non-compostable sticker could be used in the meantime. After January 1, 2026, selling or distributing non-compostable produce stickers would

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[95] Compost.Org. 2024. Global Meeting Advances Transition to Certified Compostable Produce Stickers. https://www.compost.org/wp-content/uploads/2024/10/Press_Release_Certified_Compostable_PLU_Stickers.pdf

[96] Personal communication with Susan Antler, Executive Director of the Compost Council of Canada (CCC). February 21, 2025.

[97] European Commission: Energy, Climate Change, Environment. 2025. Packaging Waste. https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en

[98] Official Journal of the European Union. 2025. O.J. (L 2025/40) 9. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJpercent3AL_202500040&qid=1737530299148

[99] U.S. Plastics Pact. 2024. U.S. Plastics Pact Problematic and Unnecessary Materials Report. https://usplasticspact.org/problematic-materials/

result in an initial warning. Fines would be an option for subsequent violations. It would be enforced by the state's Department of Environmental Conservation, and any penalties would be added to New York's environmental protection fund.[100]

While states like Washington and New York have considered regulating PLU stickers, the ICA requests states coordinate to adopt international standards for produce stickers rather than state by state regulations. The industry wants to avoid competing standards that they would need to test and track.[101] Table 2 below shows different governments who have already passed or proposed legislation around fruit stickers other than Washington.

Table 2 – Governments with produce sticker laws or proposed laws

Government	Requirements	Year Effective	Acceptable Standard(s)
European Union	Industrially compostable stickers on all produce	2028	EN 13432
New Zealand	Home compostable facestock on stickers for domestic produce Fully home compostable stickers on all imported produce	2028	AS 5810
South Australia	Phase 1: Home or industrially compostable stickers Phase 2: Fully compostable under Australian standards	Phase 1: 2025 Phase 2: 2028	2025: Any compost standard (Home or Industrial) 2028: AS 5810 (Home) and AS 4736 (Industrial)
New York	Ban on the manufacture and sale of non-compostable produce labels	Proposed for 2026	Assembly Bill A760 (2025-26) is in Assembly Committee.[102]

Table 2 Governments across the world have passed or are considering legislation to require compostable fruit stickers. The effective dates range from 2025 - 2028 and countries require stickers meet different standards for composting.

[100] State Net. 2025. 2025 NY A 760. https://custom.statenet.com/public/resources.cgi?mode=show_text&id=ID:bill:NY2025000A760&verid=NY2025000A760_20250108_0_I&

[101] Personal communication with Frank Franciosi, Executive Director, U.S. Composting Council. February 18, 2025.

[102] The New York State Senate. 2025. Assembly Bill A760 (2025-2026 Legislative Session)—Relates to Banning the Use of Non-compostable Produce Stickers. https://www.nysenate.gov/legislation/bills/2025/A760

Potential Alternatives and Related Issues

When considering alternatives to plastic PLU stickers, food safety cannot be compromised. Alternatives must be cost-effective, scalable and consider national and international trade. They also need to consider effectiveness across diverse composting systems. The main limitation to compostable stickers is their adhesive, which has limited supply. Other options like laser tattoos and food-safe stamps are still infeasible for large scale implementation. Based on timelines in Europe and Canada, phasing in compostable stickers is likely the most achievable option.[103] This section provides more information about the alternatives to plastic fruit stickers.

Compostable Stickers

The meeting on global standards for compostable produce stickers (Niagara Falls, October 1, 2024) showed the international commitment to coordinate efforts and harness momentum. With leaders from the produce industry leaders and governments across the world, the meeting led to a roadmap for developing and standardizing compostable produce stickers. The goal is a global collaboration to transition from plastic produce stickers to compostable alternatives.[104]

The switch to certified compostable stickers in the EU by 2028 accelerated plans to adopt standards. Still there are several barriers around compostable produce stickers: limited number of manufacturers, nascent development of compostable adhesives, and higher costs compared to traditional plastic labels. The few manufacturers who make stickers with compostable components (Sinclair, Accu-Label, and Elevate) may help facilitate developing and adopting international standards since a smaller pool of interests can lead to more direct decision-making.[105]

Limited supply and options for compostable adhesives is a significant obstacle for manufacturers to meet the needs of international produce markets. While the BioTAK adhesive used by Elevate shows that developing compostable adhesives is possible, it is the only known example and is exclusive to Elevate. For many manufacturers, compostable adhesives are a new topic for their research and development.

Additionally, laws in Washington, California, Minnesota, and Colorado that restrict the use of words like “biodegradable” and require compostable items meet ASTM standards have driven innovation in the industry for compostable products. In Washington, no product can use the term “biodegradable[106],”

[103] International Fresh Produce Association. 2024. IFPNA A-NZ Calls for National Approach to Fruit Sticker Ban. April 11. https://www.freshfruitportal.com/news/2024/04/11/ifpa-a-nz-calls-for-national-approach-to-fruit-sticker-ban/

[104] Compost Council of Canada. 2024. Global Meeting Advances Transition to Certified Compostable Produce Stickers. October 8. https://www.compost.org/wp-content/uploads/2024/10/Press_Release_Certified_Compostable_PLU_Stickers.pdf

[105] Kachook, Olga. 2021. Produce Stickers: the Benefits of Going Compostable. Sustainable Packaging Coalition. May 19. https://sustainablepackaging.org/2021/05/19/produce-stickers-the-benefits-of-going-compostable/

[106] The term “biodegradable” may be used for certain agricultural mulch films (RCW 70A.455.030).

"degradable," "decomposable," or "oxo-degradable." Any product claiming to be "compostable" must meet ASTM standards for industrial composting or another standard deemed comparable by Ecology.[107]

While ASTM standards (mainly D6400 and D6868) are the most common in the United States to assess a product's compostability, there are no federal standards set defining or regulating most bioplastics. Federal agencies have given some guidance and recommendations. For example, the U.S. Environmental Protection Agency (EPA) and its Environmentally Preferable Purchasing (EPP) Program recommends federal purchasers look for products certified by BPI.[108] The Federal Trade Commission's (FTC) Green Guides (last updated in 2012) provide guidance to companies when claiming their products are compostable, but they use a baseline of home compostability. [109] The Washington baseline uses ASTM standards of industrial compostability.

Even when products are certified, the compostable stickers may not break down completely at all facilities. Their performance varies depending on the conditions and processing technology used at the composting facility. To account for this variability, some certifiers like CMA have started field testing programs as part of their certification process.[110] However, other certifiers like BPI argue that current field-testing methods are not yet adequate. They think the methods are not rigorous or consistent to be used as a reliable metric of a product's compostability for standards and certification programs.[111]

Compostable produce stickers also bring about concerns around toxicity. Some chemicals used in their formulations are not necessarily derived from safe ingredients. In fact, many bioplastics contain some of the same harmful chemicals as traditional petroleum-derived plastic and some say they may have more since formulations for bioplastics contain newer chemicals without a studied history.[112]

Bioplastics made from plant materials can be contaminated by pesticides sprayed in the field or high levels of PFAS.[113] Bioplastic formulations are largely proprietary and confidential, making them hard to assess for public and environmental safety by anyone outside the company. As the industry develops compostable stickers that do not create visual or microplastic contamination like traditional stickers, they must keep in mind the potential for chemical contamination in bioplastics.

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[107] Washington State Legislature. 2024. RCW 70A.455—Plastic Product Degradability. https://app.leg.wa.gov/RCW/default.aspx?cite=70A.455&full=true

[108] United States Environmental Protection Agency. 2024. About the Environmentally Preferable Purchasing Program. https://www.epa.gov/greenerproducts/about-environmentally-preferable-purchasing-program

[109] Federal Trade Commission. 2012. Environmental Claims: Summary of the Green Guides. https://www.ftc.gov/business-guidance/resources/environmental-claims-summary-green-guides

[110] Personal communication with Janet Thoman, Compliance Director, Compost Manufacturing Alliance. February 5, 2025.

[111] Personal communication with Alexander Truelove, Legislation and Advocacy Manager, Biodegradable Products Institute. February 5, 2025.

[112] Personal communication with Alexander Truelove, Legislation and Advocacy Manager, Biodegradable Products Institute. February 5, 2025.

[113] Ferrell, Cami. 2024. Bioplastics are Inadequately Defined, Poorly Regulated, and Potentially Toxic. July. https://www.ehn.org/problems-with-bioplastics

Laser Etching

Laser etching is an alternative technology to plastic produce stickers that uses a low-intensity carbon dioxide laser to etch information on the outer layers of fruit or vegetables. The FDA regulates laser etching for use in certain contexts. It was approved in 2012 for use on citrus fruits.[114] While laser printing does not need paper, plastic, ink or adhesives, it would require switching from stickering to laser technology. Such an upfront cost would be significant for produce packing houses. We did not find any information about existing laser etching equipment operating in Washington.

Studies and pilots from outside Washington suggest that laser etching could be used in commercial applications for soft skin fruits.[115, 116, 117] However, laser printing technology is not compatible with all fruit, especially rough fruits like pineapples. Some fruit will "heal" the laser etchings, rendering the mark invisible or significantly obscuring information. In other unsuccessful examples, etching on delicate produce like tomatoes causes the skin to rupture and promotes faster food spoilage.[118]

Ink-based Printing

Ink-based printing, or "vegetable tattoos," are another alternative technology to plastic produce stickers. It uses food-grade ink to stamp item information onto the outer skin. This approach works well for smooth skinned fruits that have an even surface for printing like mangoes or apples. However, the technology does not work on rough skinned produce like pineapples and avocados. Ink printing also lacks significant moisture resistance, and the stamp can rub off through the supply chain.[119] For ink-based printing to be reliable, the ink must stay protected during handling and washing.

Ink printing has similar challenges to laser etching like its upfront costs and scalability. Scalability considers whether the technology can be used at the scale necessary to meet the needs of operations across Washington. Ink printing would require a wholesale switch in infrastructure.

Like laser etching, we did not find any information about existing ink-printing facilities or equipment in Washington suggesting the industry would be built from the ground up. When compared to compostable stickers that can use Washington's existing infrastructure at packing houses, the benefits of eliminating all external packaging material may not outweigh upfront costs and doubts about scalability.

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[114] Code of Federal Regulations. 2012. Section 179.43 Carbon Dioxide Laser for Etching Food. June 11. https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-179/subpart-B/section-179.43
[115] Khada, Durga, et al. 2024. CO2 Laser Labeling on Fresh Produce: Evaluating Postharvest Quality, Microbial Safety, and Economic Analysis, Journal of Food Protection. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133
[116] El.En. Laser. 2021. Laser Labeling of Food with Laser Marking. https://elenlaser.com/newsroom/insights/laser-labeling-of-food-with-laser-marking
[117] Sood, P. et al. 2009. Laser Etching: A Novel Technology to Label Florida Grapefruit. January. https://journals.ashs.org/horttech/view/journals/horttech/19/3/article-p504.xml
[118] Kachook, Olga. 2021. Produce Stickers: Are they the Next Straw? Sustainable Packaging Coalition. May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/
[119] Kachook, Olga. 2021. Produce Stickers: Are they the Next Straw? Sustainable Packaging Coalition. May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/

Summary

Extensive research and outreach efforts showed that plastic fruit stickers and their alternatives have both pros and cons when it comes to their impacts on partners and applying to diverse industry conditions. The rest of this report discusses these considerations, so future decisions can be made with the best information available. We look at the current impact of plastic stickers, local infrastructure conditions to manage and process alternatives, certification and regulation for alternatives, the status of alternative technologies, and the international efforts aimed at using alternatives to plastic stickers.

As the international community works to standardize compostable stickers, this points to requiring their use. However, a hybrid environment will likely exist at least temporarily. Where plastic and compostable plastic stickers are both used but in different markets. We also must consider that retailers could opt for more bagged or plastic wrapped material. This possibility points to the need for ongoing market reviews as produce sticker options are developed. Participating in the international workgroup's ongoing conversations could be beneficial and facilitate that ongoing status review.

Outreach

Greene Economics talked with key industry leaders, actors, and technical experts to get a deeper understanding of their needs, constraints, and opportunities. We also wanted to fill in significant gaps from our other research. This chapter summarizes interviews and other communications with key insights from conversations.

Process

Working with Ecology and WSDA, Greene Economics identified key leaders and actors for in-depth interviews and email communications. The goals were to better understand partner needs, constraints, and opportunities. Based on findings, Greene Economics spoke with farmers, sticker producers, researchers, technical experts, certifiers, and others knowledgeable about produce stickers. Through these conversations we got greater understanding of existing sticker technologies and how they might work for growers and packing houses. Interview results are included in the overall analysis and integrated throughout this report.

Greene Economics interviewed people from the following sectors:

- Produce farmers, packers, and distributors.
- Sticker and adhesive producers.
- Other states, countries, or subnational jurisdictions that have adopted standards restricting plastic produce stickers.
- Washington compost facility operators.
- Washington materials recovery facility producers.
- Certifiers.
- Other technical experts.

Interviews and Takeaways

This is a list of people contacted during the outreach process. It has the contact and key takeaways from the interview.

Bioplastics industry

Dan Martens, Vice President, Novomont North America (Interview)
Novomont is not a sticker manufacturer. They are a key participant in the international collaboration on international standards with their involvement in compostable plastics manufacturing. Novomont provided other key contacts to reach out to.

Certifiers and standards-setting bodies

Alexander Truelove and Margaret Eldridge, Biodegradable Products Institute (Interview)
BPI is a non-profit that certifies compostable products to ASTM standards (for produce stickers ASTM D6400 or D6868). They are an active member of ASTM and the D20.96 subcommittee relating to produce stickers. Products are tested strictly via lab testing by third-party laboratories approved by BPI for ASTM. PFAS tests are also done by TF analysis. Compliance and results are put through a technical review by their third-party technical authority DIN CERTCO.

BPI does not feel that current field-testing methods are sufficiently rigorous or reliable, but they do serve to demonstrate the compost facility has sufficient conditions to meet the decomposition standards outlined in the lab analysis. They are involved in ASTM review of potential new standards for field testing to be added to ASTM standards. BPI has also submitted a petition to the NOP/USDA to update the list of acceptable inputs for organic farming to include products certified to appropriate ASTM standards.

Janey Thoman, Compost Manufacturing Alliance (Interview)
CMA is a third-party certifier for compostable products to ASTM standards (for stickers ASTM D6400 and D6868). CMA started as a field-testing program for Washington compost facility Cedar Grove and grew into an international certifying body. CMA requires field testing in their certification process plus third-party lab testing for ASTM and PFAS (tested by TF analysis) compliance.

CMA is an active member of ASTM and their D20.96 subcommittee. They have been working to help pass ASTM standards for field testing compostables. CMA also has a "Substrate Acceptance" program. This is for products that have compostable elements but do not meet ASTM standards for all components. These supplemental standard supports "harm reduction" to reduce plastics in a phased approach as fully compostable products develop and become more accessible.

Matt Pezzella, Craig Updyke, Alison Fick, Kevin Okamoto, Various Roles, American Society for Testing and Materials (Interview)
ASTM is a standards development agency. They create standards which certifiers test against, but do not test, enforce, or write standards for specific products. ASTM is composed of a main committee and subcommittees. Subcommittees are composed of niche experts on specific issues to be addressed.

Produce stickers fall under main committee D20 (Plastics) and subcommittee D20.96 (Environmentally Degradable Plastics and Biobased Products). The two standards ASTM has for produce stickers are D6400 (for single-layer products) and D6868 (for multi-layer products). New standards are developed through a process of "balloting." Subcommittees initially propose something, and it progresses through to the main committee for approval by all ASTM members before it is published.

Doug Currier, Organic Materials Review Institute (Email)
OMRI works with the NOP to develop technical reports for the National Organics Standards Board on what materials are allowed to be used in organic farming. OMRI also works closely with the WSDA to ensure they are consistent with their reviews of brand-name inputs. OMRI is a completely voluntary program, where composters choose to have their product verified as an input for organic farms.

The process requires that all facilities list all feedstocks used/could be used to make compost and where they come from when applying for OMRI approval. Composters can accept materials with compostable plastics if they can prove removal and describe the process. Plastic stickers fall into a category of contaminants that do not require a plan to remove them. This form of contamination is typically addressed in response to a complaint.

Compostable adhesive manufacturers

Jim Holbery, CEO/President, Nvirovate Materials Inc (Email)
Nvirovate is developing a potential adhesive that could develop a product fit for compostable stickers.

Erin Levine and Deven Young, World Centric (Email)
World Centric primarily manufactures compostable serviceware and does not manufacture stickers.

Composters

Susan Antler, Executive Director, Compost Council of Canada (Interview)
Susan Antler was the designer and organizer for the first international summit in Niagara Falls, where global participants discussed standards for produce stickers. The meeting also brought together nations with produce sticker laws and/or standards. She provided conference findings, working group updates, and contacts to other key attendees.

Gavin Schmidt, Facility Manager, Dirt Hugger (Interview)
The bulk of sticker contamination for Dirt Hugger comes from the local pear industry sending loads of stickered produce from cold storage when the produce is no longer salable. Common operating permits for compost facilities allow up to 5 percent contamination by volume, a threshold that stickers would never reach to cause outright load rejection. Based on operational practices at compost facilities, stickers in feedstocks are virtually guaranteed to end up in finished compost, as no contamination management method is reliably effective at removing them. All their finished compost is approved for use on organic farms, and plastic stickers do not impact the opportunity due to incidental amounts in the total load.

If all stickers were compostable, this could cause issues as compostable stickers are a prohibited material under the NOP. Unless this was changed, a transition to compostables could force them to deny high-risk feedstocks such as stickered produce from cold storage locations and post-consumer food waste.

Jay Blazey, Legal and Policy Analyst, Cedar Grove Composting (Interview)
Cedar Grove is the largest composter in Washington and maintains separate processing streams for organic approved and non-approved compost. For organic compost, their facility designates a specific route for certain feedstocks to avoid contamination with feedstocks that are not approved under the NOP. Plastic stickers are technically allowed in organic compost as “incidental contamination,” but a certified compostable sticker could raise flags for organic certification as compostables are prohibited feedstock materials under the NOP.

Cedar Grove developed field testing methods for compostable products in the early 2000s that expanded and become the basis of the CMA**.**

Scott Deatherage, Barr Tech Compost Facility (Phone)
Barr-Tech does not receive enough food waste for stickers to be an issue. This is not a topic they have a lot of experience with.

Samantha Winkle, Silver Springs Compost (Interview)

Waste Connections manages three compost facilities in Washington and has been part of the compostable sticker dialogue. They screen for a very fine compost, which is back blended with soil to make various mixes. They see plastic stickers end up in their finished compost and accept the plastic as incidental contamination.

Frank Franciosi, Executive Director, U.S. Composting Council (Interview)
The U.S. Composting Council is a key actor in the international consortium that met in Niagara Falls on October 1, 2024. USCC continues to support the ongoing conversation to collaborate on developing international standards for compostable stickers. Franciosi confirmed that the U.S. Composting Council is following the recommendation of the ICA that requests state coordination in support of the international standards rather than state by state regulations for produce stickers.

Sticker and produce labeling industry

Will Murray, Senior Director of Operations, Sinclair Systems International (Interview)
Sinclair is the primary sticker manufacturer in Washington with a facility located in Wenatchee. They make plastic and compostable stickers, as well as stickering equipment, which they sell or lease. Sinclair could not provide a map of stickering locations in Washington. While they gave us some limited cost information, Greene continued to reach out to packagers for additional cost information to compare. Sinclair introduced Greene to the on-demand print option being used by smaller packaging operations. This system requires using direct thermal labels and equipment integrated with direct thermal printers. These facilities need 3-5 years to develop the material technology to support this infrastructure. Sinclair mentioned that paper stickers should not be exempt and should be tested, as they can contain things like PFAS that should be included in testing requirements.

Rod Baieni and Derek Sorrell, Accu-Label (Interview)
Accu-Label (a subsidiary of AgTronic) makes paper-based PLU stickers and supplies largely to Michigan, New York, and Ontario. Accu-Label's products are an end-to-end product of AgTronic, meaning their materials, equipment, design, etc. are all done through and by the company. According to Sorrel, there are no added costs for their paper label as opposed to plastic.

Their paper-based sticker meets virtually all compostability standards from CMA apart from a slight lag in biodegradability from the non-compostable adhesive. Their stickers are not officially "certified" compostable but are an "accepted" product under CMA's "Substrate Acceptance" program. This CMA-S program is a limited acceptance supporting "harm reduction" to reduce plastics for composters and the environment. Accu-Label is in the process of developing a compostable adhesive that will make their products fully compostable.

Richard Cohen, Elevate Packaging (Interview)
Elevate is a U.S.-based compostable packaging company offering compostable produce labels certified under D6400 and EN 13432. After consolidating with Bio4life, Elevate has exclusive rights to the world’s only compostable adhesive (BioTAK). Their stickers can fit into existing labeling equipment.

Elevate doesn’t sell any labels in Washington as Cohen believes there isn’t really a drive for the produce industry to use compostable unless pushed by legislation. Produce labels are currently only a small part of their business and mostly sold in Europe where packaging laws are coming online.

Agricultural producers

Jon DeVaney, President, Washington Fruit Tree Association (Interview)
Washington produce is largely consolidated through warehouse packaging centers that manage produce from large number of farmers. Retail chains are driving the conversation about labeling, as they dictate what sort of packaging they want. Jon provided other key contacts in the industry.

Matt Harris, Washington State Potato Commission (Interview)
Potatoes and onions are largely not labeled with stickers but primarily sold in bulk bags. Potatoes are damp for much of supply chain processes and labels do not adhere well to the wet peels. Some onions are labeled with stickers. Harris shared that most produce packers have their own label and will co-pack with major retail chains, indicating that outreach and conversation with retailers is key to understanding the main drivers of conversation, action, and demand around PLU labels.

Mikey Hanks, Operations Manager, Washington Fruit and Produce Co. (Email)
Produce labeling is almost entirely done on packing lines at large packing warehouses using on-line labeling equipment. Apples that do not meet specs for fresh produce retail are sent by packers to food processors (juicing, slicing, etc.) or cattle feed operations.

Bob Wymore, Diamond Fruit Grower (Email)
Apples and pears are stickered on packing lines most of the time. Because pears are typically labeled while still wet, this necessitates an adhesive that is strong enough to adhere to fruit skin in the presence of moisture and stay on when eventually dry. Apples are stickered after drying. Produce may be stickered at cold storage facilities but not often.

Keith Mathews, Yakima County Horticultural Pest and Disease Board (Email)
The Yakima-Tri-Cities area grows about 9 billion apples annually, around 90 percent of which are stickered using on-line labeling systems. Virtually all stickering occurs on packing lines after fruit is sorted, washed and waxed. Mathews estimates there are around 100 fresh packing houses in WA, all of which are labeling produce.

Ben Barnes, Production Manager, Borton Fruit (Interview)
Yakima County is estimated to have 15 packing houses using print-on-demand (POD) systems including Borton Fruit. Statewide estimates were not available. Direct thermal labels used for POD systems generally cost more than traditional pre-printed plastic labels due to the more expensive raw materials used.

Regulatory agencies

Jared Clark, Erin Healy, and Devon Pattillo, National Organic Program, USDA (Interview)
The NOP manages development, implementation, and administration of standards for certified organic agricultural products. The NOP is not directly involved in determining whether a given compost product is able to be used on an organic farm. Agencies like OMRI verify that compost production meets organic standards.

The NOP oversees the certifiers of organic farms, i.e. agencies that look at organic operations. Certifiers like OMRI look at certain inputs to make sure they align with organic standards. The National Organics Advisory Board meets twice a year and gives recommendations to the NOP on what substances should be allowed or prohibited. These recommendations are open to public

comment before these meetings. Every five years, all allowable and restricted materials are reviewed by the Board.

Robert Newell, Program Manager, WSDA (Interview)
There are 95 to 100 packing warehouses in Washington that label and pack around 6 million 40-pound cartons of produce annually. There are also some smaller operations labeling around 1 to 2 million cartons annually.

Apples are the primary produce item labeled with produce stickers in addition to pears. Not as common are onions, stone fruits, and sometimes potatoes. The packing and shipping processes for apples and pears is similar and uses various stages of cold storage. Fruit ends up packed into trays and loaded into boxes (the industry standard is 40 pounds/box).

When stickered, onions and potatoes follow similar processes to one another and diverge from apples and pears in terms of storage and packing. Most onions and potatoes will go straight to packing lines. The rest are put in ambient temperature storage and are packed later as loose produce into boxes rather than in trays.

Environmental groups

Heather Trim, Executive Director, Zero Waste Washington (Interview)
Zero Waste Washington was very active in hearings for HB 2301 when a produce sticker ban was initially proposed. They lobbied for the ban to be scaled down to a study when it became clear that there were many concerns still to be addressed. Trim is particularly concerned about understanding the health impacts of microplastics in soil resulting from items like plastic produce stickers.

Grocery and retail industries

Tammie Hetrick, Connie Carlson, and Katie Beeson, Washington Food Industry Association (Email)
Contacts stated they did not have extensive knowledge on this topic and would not be a helpful resource. Recommended talking to the WA State Farm Bureau.

Rose Gundersen, Vice President of Operations and Retail Services, Washington Retail Association (Email)
The Washington Retail Association is not heavily involved in the ongoing discussion about produce sticker technologies. Gundersen was present at the initial hearings for HB 2301 when a ban for non-compostable stickers was presented. Their main concerns on PLU stickers are customer safety (produce tracking) and accurate pricing (scanning at POS).

Assessment of Produce Sticker Technologies

This chapter presents an analysis of alternate produce sticker technologies using a combination of primary and secondary research and analysis. We aim to summarize the technology options and their impacts for key actors in Washington.

Alternatives Considered

We looked at the following alternatives based on research and interviews:

Plastic stickers (current technology)
Compostable stickers
Laser etching
Ink-based printing

Plastic Stickers (Current Technology)

Conventional plastic stickers are a composite made of a plastic facestock (where the PLU information is printed), ink, and adhesive. Produce stickers use a class of adhesives known as pressure-sensitive adhesives (PSAs), which are designed to adhere to a surface when pressed on and easily come off when pulled away.[120]

Technology process

Washington's infrastructure was built to support stickering technology. The type of equipment used varies based on the produce and whether items are being labeled individually or in bulk trays. Sinclair supplies produce labels and labeling equipment in Washington. They have two general categories of equipment: on-line and pattern labelers. Online labeling equipment runs separate lanes of conveyor belts that hold fruit under an applicator. Fruit gets stickers one at a time as lanes run at high speeds.[121]

Pattern labeling is used for produce packed in bulk trays which protects fruit like apples and pears. This technology works much the same as on-line equipment, but instead of running multiple lanes at a time, there is one large lane that moves full trays of fruit under the applicator to be labeled in one pass.[122]

There is another type of sticker labeling technology called "print-on-demand" (POD) systems. These are used when sticker information is variable; so, the packing house prints them on demand instead

[120] Creton, C. 2003. Pressure-Sensitive Adhesives: An Introductory Course. https://ccreton.simm.espci.fr/sites/ccreton.simm.espci.fr/IMG/pdf/june03_creton.pdf
[121] Sinclair Systems International. 2025. Sinclair RM6 Technology. https://www.sinclair-intl.com/labeling-systems/on-line-labelers/rm6/
[122] Sinclair Systems International. 2025. Pattern Labelers: Sinclair CR4 pattern labeler technology. https://www.sinclair-intl.com/labeling-systems/pattern-labelers/cr4/

of bulk stickers being printed in advance. This system needs additional equipment like direct thermal printers[123] and special stickers that are different than bulk-printed versions.[124]

Packing houses use print-on-demand systems when the handle many different varieties at the same time, or when retailers need specialty designs. This dynamic type of labeling is critical for produce like apples, that have many varieties with different prices. Each variety needs a different PLU code. An on-line or pattern system would require pre-printed labels that need to be changed for each variety of apple or other fruit. In POD systems, stickers can be printed as needed and easily changed between items. We did not find the number of POD systems in Washington, but Yakima County has around 15.[125]

Applicability to diverse fruit types

Plastic stickers have been the grocery industry standard since the establishment of Price Lookup Codes by the IFPS in 1990.[126] Stickers work across a wide range of produce types and hold up through washing and handling in the supply chain. They stay on produce and are readable at the final point of sale.

Costs and labeling throughput

Given that plastic stickers are the current standard, continuing to use them would not have substantial costs for the produce industry. Composts bear most of the impact from plastics stickers. Compost is lower quality due to plastic contamination, although no facility gave a dollar amount for the value loss.

Packing houses pay $1.00 - $6.00 for one thousand plastic produce stickers depending on variables like size, material, and print complexity.[127] For Washington apples, one thousand stickers range from $1.57 - $2.33 plus costs of equipment and staff.[128]

We found limited information about the cost of stickers for POD operations. However, some shared the retail cost for one thousand POD stickers is higher than pre-printed stickers because the raw materials for POD stickers are more expensive. Sources also said the labeling equipment for POD systems was more expensive than standard labeling equipment.[129] [130]

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[123] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. March 10, 2025.
[124] Hally Labels. 2024. Understanding Thermal Labels: Direct Thermal vs. Thermal Transfer. https://www.hallylabels.com/labels-blog/understanding-thermal-labels-direct-thermal-vs-thermal-transfer/
[125] Personal communication with Ben Barnes, Production Manager, Borton Fruit. March 11, 2025.
[126] Olaechea, C. 2023. How to Decipher PLU Codes on Fresh Produce. https://www.eatingwell.com/article/8044090/how-to-decipher-plu-codes-on-fresh-produce/
[127] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. 20 December 2024.
[128] Personal communication with Mikey Hanks, Operations Manager, Washington Fruit and Produce Company. February 19, 2025.
[129] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. March 10, 2025.
[130] Personal communication with Ben Barnes, Production Manager, Borton Fruit. March 12, 2025.

The industry measures throughput by the number of items that can be labeled per hour. Since produce is perishable, throughput needs to be high to prevent spoilage. The Sinclair on-line labeling technology can sticker up to 43,200 items per hour per lane and run up to 20 lanes at a time.[131] Pattern labeling equipment can sticker trays with up to 16 rows of fruit per tray and process up to 2,640 trays per hour. The number of items per tray varies.[132]

Packing houses require at least 95 percent of stickers demonstrate "good adhesion." This means stickers stay attached to the produce and conform to its shape and texture.[133]

Compostable Stickers

Like their plastic counterparts, compostable PLU stickers are made of a facestock, ink, and adhesive. Manufacturers have tried different materials for compostable facestocks, including bioplastics, paper and other fibrous materials.

Technology process

For packing houses using on-line and pattern labeling equipment, compostable stickers reportedly work with the current infrastructure and equipment without any retrofitting or alterations.[134]

For POD operations, however, there is no compostable option currently available for the thermal labels used in this system. Manufacturers estimate a market-ready option for POD operations could be available in three to five years.[135] Our interviews noted that if compostable labels were required, packing houses that use POD systems could be impacted. According to Wil Murray (Sinclair Systems International), the complexity and cost for POD packing houses to switch back to pre-printed stickers with different equipment would be significant.[136]

Applicability to diverse fruit types

In general, compostable stickers function similarly to plastic stickers. They can adhere to many produce types. However, a key obstacle for compostable PLU labels is the limited availability of certified compostable adhesives. To match the performance of plastic produce stickers, compostable adhesives must retain the strength and versatility needed for the expected 95 percent adhesion rate, so they stick to a range of produce shapes and textures.

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[131] Sinclair Systems International. 2025. Sinclair RM6 Technology. https://www.sinclair-intl.com/labeling-systems/on-line-labelers/rm6/

[132] Sinclair Systems International. 2025. Pattern Labelers: Sinclair CR4 Pattern Labeler Technology. https://www.sinclair-intl.com/labeling-systems/pattern-labelers/cr4/

[133] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

[134] Elevate Packaging. 2024. Stick to Sustainability: Compostable Produce Labels. Presented at the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.

[135] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

[136] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

Costs and throughput

Sticker producers explain that compostable stickers can be used in existing equipment for conventional plastic stickers.[137] [138] As a result, the primary costs of a transition to compostable stickers from traditional plastic stickers would be higher per-sticker costs. Compostable stickers cost more than plastic versions. Newly developed models and materials like bioplastics and adhesives could cost even more depending on how much was invested in research and development. Although, costs could come down over time as production and demand grow.

Sinclair is one of two sticker manufacturers with a certified compostable sticker on the market. They say a mid-range sticker price for a plastic sticker is about $3.00 for one thousand labels. This is 24 cents to label a standard 80-count box of fruit. One thousand compostable labels would cost $4.80 for one thousand labels, or 38 cents for an 80-count box of fruit. In this instance, the increase would add about 14 cents to label a box of fruit. Assuming an 80-count box of a given fruit sells for $30.00, using compostable stickers adds 0.48 percent for a box of produce that would need to be covered by the farmer or packing house.

While the increase per box seems reasonable, farmers and packing houses work on very tight margins. They manage costs per box of fruit down to the penny. The per-unit cost needs to be expanded at the scale for the industry. Each packing houses buys more than ten million stickers every year. If farmers and packing houses must switch to compostable labels,[139] we presume costs will be passed on to consumers through higher food prices.

As EU, Australia, New Zealand, and Canada adopt compostable stickers, their costs will likely come down over time.

While costs would be added in the agriculture and labeling chains, compostable stickers may help compost facilities save money. Composters experience costs from plastic stickers most directly through loss of compost value from plastic contamination.

Since compostable stickers can fit into the current on-line and pattern equipment, throughput times and volumes are reportedly consistent with plastic stickers. In other words, stickers go on up to 43,200 items per hour per lane for on-line labeling, and up to 2,640 trays per hour for pattern labeling (based on Sinclair Systems International).[140]

Research and development

There are only a few compostable stickers on the market, so more research and development is needed for more options. Increasing availability and diversifying options is considered key for

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[137] Elevate Packaging. 2024. Stick to Sustainability: Compostable Produce Labels. Presented at the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.
[138] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. 20 December 2024.
[139] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. January 20, 2024.
[140] Sinclair Systems International. 2024. Labeling Systems. https://www.sinclair-intl.com/labeling-systems/

compostable stickers to work at the scale needed by industry. The most pressing issue is developing more compostable adhesives.

An example is POD operations. Direct thermal labels have no compostable adhesive option, so research and development would be a prerequisite for these operations. These operations are essential to the Washington apple industry, which needs POD at packing houses who work with many different apple varieties. Sources say a compostable POD sticker is 3 to 5 years away[141]. If Washington banned plastic stickers or required compostable ones, POD packing houses may need special consideration based on available technology and options.

Laser Etching

Laser etching PLU information onto the surface of fruits and vegetables is an alternative to plastic PLU stickers. Laser etching eliminates the use of plastic and other non-compostable labels on produce that can impact facilities and contaminate finished compost. No plastic would prevent downstream impacts to and water from microplastics and chemicals of concern.

Laser etchings are a permanent engraving on the exterior layer of produce. Etchings cannot detach or wash off through the produce supply chain like adhesive stickers. This avoids losing PLU information and maintain accurate pricing, sourcing, and more efficient food safety recalls.

While laser etching has less environmental impacts, there are significant economic, logistical and technological barriers. These suggest that laser etching is not a feasible option given current industry conditions.

Technology process

Laser etching uses a low-energy carbon dioxide laser beam to engrave information on the outer layers of produce and expose a contrasting underlayer.[142] The fruit naturally secretes chemicals around the laser marks that help maintain its structure[143] and keep water from escaping or unwanted microbes coming in.[144] Laser etching has been tested in limited markets. Our extensive research and outreach did not show any laser operations in Washington.

Applicability to diverse fruit types

We did not find any standard procedures or protocols for laser etching produce. The fruit skin plays a role in how well laser marks perform. Mark quality is inconsistent across different produce. This applies to the clarity of the mark and how well it holds up in the supply chain.

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[141] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[142] Sood, P. et al. 2009. Laser Etching: A Novel Technology to Label Florida Grapefruit. January. https://journals.ashs.org/horttech/view/journals/horttech/19/3/article-p504.xml
[143] Lignin Institute. 2001 July. Lignin and its Properties. https://web.archive.org/web/20071009010219/http:/www.lignin.org/01augdialogue.html
[144] Khadka, D., et al. 2024 September. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

Fruits and vegetables have a variety of skin types with different thicknesses and sensitivity to lasers. This affects how compatible laser marking is with different produce. Etching is best suited for the hearty peels on items like avocados or grapefruits. These have many layers that can be removed before reaching the flesh of the item. Research shows that lasers can break the delicate skin of fruits like tomatoes, which compromises its quality. Other produce like pomegranates, mandarins, oranges, and lemons have can heal over engravings to the point where they are illegible at the final point of sale.[145]

For Washington-grown produce, apples respond relatively well to laser etching as the smooth, waxy surface is ideal for engravings. However, laser marks on apples make the fruit more susceptible to microbial growth and fresh weight loss.[146] Microbes can cause foodborne illness and weight loss reduces profits for items sold by weight.

Other Washington crops like pears and stone fruit have thin skins that are likely to get damaged. A pear's shape may also pose challenges for laser engraving. Oblong and inconsistent shapes make setting the laser difficult and can make markings unreadable.

Microbes and water loss

The size and detail of a marking impact its quality and effectiveness. Larger markings can speed the rate of produce deterioration from microbes and water loss. Studies show the lines in barcode-type marks grow more bacteria than QR-code formations or marks that use numbers and letters. In a study of laser etching on apples, bell peppers and cucumbers, "all three [crops]… with and without wax had significantly higher [colony-forming units] than the non-etched control." The colony-forming unit measures microbial growth[147].

Larger engraved marks means higher risk for water loss and microbe growth. Even with fruit's natural defenses to seal the mark or using wax coatings, "laser engraving compromises the protective barrier of the produce surface."[148] Compromised protective barriers on produce could lead to higher rates of foodborne illness and produce spoilage that leads to food waste.

Color contrast

Color contrast also poses challenges to the quality of engraved labels. Even when produce retains the mark, a minimum level of contrast is needed between the produce skin and mark. Otherwise, PLU information cannot be used. In a study about etching on dragon fruit, results showed that even

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[145] Kachook, O. 2021. Produce Stickers: Are They the Next Straw. May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/

[146] Khadka, D., et. Al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

[147] Walton, D. 2022. What Is a CFU in Microbiology? March 24. https://www.sciencing.com/cfu-microbiology-15601/

[148] Khadka, D., et. al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

when a mark was visible to the human eye, "the scanner could not distinguish [the barcode] from the fruit surface due to insufficient color contrast."[149]

The need for sufficient color contrast with laser etching raises questions about consumer acceptance. No studies looked at how consumers responded to laser etched produce. Consumers may initially be wary of etched produce and need time to learn about the new technology.

Costs and labeling throughput

Certain studies of laser etching have boasted faster labeling times compared to plastic PLU sticker lines that make up for upfront installation costs.[150] However, other sources have shown that current laser etching technology has slower throughput times than current sticker operations. Standard labeling times for laser etching are not widely available, so data is extrapolated from existing pilots and studies, which have shown that labeling times vary greatly depending on the size and complexity of the design being used. In a pilot study by El.En. Laser, a research and development company for laser technology—marking traceability codes onto apples, the laser etching technology was able to mark six apples per second, a time frame considered to be "extremely fast" based on existing data for laser marking.[151] But comparing these times to current stickering operations that are able to label up to 720 apples per minute[152]—or 12 per second—labeling times considered fast under laser etching technology are still twice as slow as existing sticker labeling infrastructures. In the previously mentioned 2024 study on laser etching for apples, bell peppers, and cucumbers, labeling times for QR-code etchings—a more complex engraving design—took about fifteen seconds *per item* compared to PLU stickering systems that can apply a label every 0.3 seconds.[153]

Research and development

Research and pilot programs show that laser etching needs further development for it to be a feasible option in Washington. Specifically, we need to "improve etching speed and optimize laser parameters for each commodity to meet the industry's needs."[154]

A transition to laser etching technology would significantly disrupt Washington's current labeling infrastructure and packing house operations. There are many areas for further work like

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[149] Sree, T.K. and Natarajan, V. 2022. Laser Labeling on Dragon Fruit with Different Codes and their Impact on Surface Characteristics. June 27. https://www.thepharmajournal.com/archives/2022/vol11issue7S/PartBC/S-11-7-619-961.pdf

[150] Khadka, D. et al. 2024. Evaluating Consumers' Acceptability of Laser-labeled Apple Fruit. December. https://www.sciencedirect.com/science/article/pii/S2666833524001072

[151] El.En. Laser. 2021. Laser Labeling of Food with Laser Marking. https://elenlaser.com/newsroom/insights/laser-labeling-of-food-with-laser-marking/

[152] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

[153] Khadka, D., et. al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

[154] Khadka, D., et. al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

standardized laser settings, dealing with variation in produce skins, reducing microbial contamination, and optimizing design complexities to make laser etching more consistent and effective.

Laser etching cannot handle the different crops grown in Washington and does not have enough speed to meet the needs of Washington's produce industry. We also need to know more about how customers will respond to laser etching on their produce.

Ink-based Printing

Another alternative to plastic PLU stickers is ink-based printing or "vegetable tattoos." This technology prints PLU information on the produce skin with food-grade ink. Ink has similar benefits to laser etching with no external materials like films or glues. It is a compost friendly labeling option that cannot detach from produce through the supply chain. While ink-based printing has less environmental impacts than stickers, there are significant gaps in research. There are also functional and economic barriers that suggest ink printing is not feasible to implement in Washington under current conditions.

Technology process

Food-grade ink is used to print PLU codes or other marks on the surface of fruit and vegetables. Research and outreach did not identify any ink-printing infrastructure or operations in Washington. In fact, the lack of information about ink-based printing operations in Washington, the U.S., and the globe suggests a lag in research and development. Given there does not seem to be any ink-based printing facility or equipment in Washington, ink-based printing is unlikely to meet the needs of Washington's fruit and vegetable industry.

Applicability to diverse fruit types

There is no external label at risk of falling off with ink-based printing. However, ink can easily rub or wash off during cleaning, transport, and storage before produce makes it to market.[155]

Ink-based printing varies widely in its quality depending on the item's shape, size, and texture. Ink tattoos pair well with smooth-skinned produce like mangoes and lemons. Items with rough skin like pineapples and avocados or fuzzy fruit like kiwis and peaches hinder the printing and ink marks.[156]

For Washington-grown crops, ink-based printing may work with smooth, even fruits like apples. It may be more difficult with pears, onions or apricots with rougher surfaces and oblong shapes. We did not find any information on how consumers respond to fruit and vegetables with PLU information stamped on their surface.

[155] Cui, Xiurui, et. al. 2022. Multitiered Fresh Produce Supply Chain: The Case of Tomatoes. December. https://www.researchgate.net/publication/366354985_Multitiered_Fresh_Produce_Supply_Chain_The_Case_of_Tomatoes

[156] Kachook, O. 2021. Produce Stickers: Are They the Next Straw? May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/

Technology conversion

Like laser etching, a transition to ink-based printing would disrupt Washington's current labeling infrastructure, resulting in significant implementation costs for growers, packing houses, and consumers.

Costs and labeling throughput

We did not find any information about throughput for vegetable tattoos or efficiencies for the technology.

Research and development

Research for ink-based printing has gaps. There are only a few pilot projects and significant information gaps around throughput and efficiency. Before deciding to invest in pilots, we need to understand the potential impact a wholesale switch in technology would have on farmers and packing houses. It may be that the upfront costs are too large for ink-based printing to be a feasible alternative to plastic stickers in Washington.

Decision Criteria

We compared options for produce labeling technologies across key criteria including compostability, toxicity, printability, and performance. We also looked at external factors like policies and cost impacts to various actors. Research helped analyze each alternative across the suite of criteria from the legislature. These criteria were:

- Factors of compostability in relation to applicable compost standards and impacts to state compost facilities.
- Hazardous or toxic substances found in any component of alternative technologies.
- Printability and application efficiencies addressing labeling times and throughput volumes.
- Performance of PLU labels for legibility throughout supply chain processes and adhesion in the case of stickers.
- Cost considerations for plastic sticker alternatives.
- Existing or impending legal policies and frameworks, domestic or international, that impact the use or implementation of any given alternative.

Each of these is discussed in more detail in the proceeding sections.

Compostability

There are recognized standards for how a compostable product (including stickers) should perform in an industrial compost facility. These include ASTM D6400 and D6868 (U.S.), EN 13432 (EU), AS 4736 (Australia), TUV Austria's OK Compost INDUSTRIAL, and ISO 17088/18606. While there are differences between standards, they all focus on four categories:

- characterization (heavy metal and trace element concentrations)
- biodegradation (ability of each product ingredient to break down into natural substances within a given timeframe),[157]
- disintegration (the ability of a product to break down into certain sized particulates within a given timeframe),[158] and
- ecotoxicity (the potential of a product and its ingredients to negatively impact ecosystems)[159] (see Table 3).

Disintegration is used to measure the potential impacts of compostable stickers on Washington compost facilities, since it is related to the potential for visual contamination of finished compost.[160] However,

[157] Henderson, T. 2023. Biodegradability Testing: A Comprehensive Overview. https://outsource.contractlaboratory.com/biodegradation-testing/
[158] Briassoulis, D., et. al. 2010. Critical Review of Norms and Standards for Biodegradable Agricultural Plastics Part II: Composting. https://link.springer.com/article/10.1007/s10924-010-0222-z
[159] Aropha. 2025. Everything You Should Know About Ecotoxicity Testing. https://www.aropha.com/resources/blog/everything-you-should-know-about-ecotoxicity-testing/
[160] Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.

even when a product is certified by lab testing for one of the scientific standards, compostable products often behave differently at the compost facility. Real conditions at compost facilities are different than lab settings, so performance results can differ from what is seen in the lab. This explains why composters want more standard field-testing methods to assess and certify compostable products.[161]

Washington law allows some compostable products to use ASTM D6400, D6868, D8410, ISO 17088, EN 13432; or another standard that Ecology finds comparable for certification.[162] These standards require disintegration to pieces smaller than 2 millimeters within 12 weeks to eliminate visual contamination in finished compost (see Table 3). However, disintegration will vary from facility to facility depending on the processing method and site conditions over the 12 weeks.

Most Washington compost facilities use aerated static piles to process compost.[163] If compost facilities are to benefit from compostable stickers and less contamination, it is critical that stickers break down in these systems and in the right amount of time. Facilities will need to monitor their operations to see if compostable stickers are completely and consistently breaking down.

The main differences between different country's standards for compostability are around limits for heavy metals and trace elements (see Table 3). The EU's standard (EN 13432) has the strictest standards for compostable products. Sticker manufacturers strive to meet EN 13432 because they consider it the highest bar. Meeting the strictest standard theoretically keeps the most trade options open with other countries for fruit and vegetables.

If stickers are certified to meet EN 13432 standards, then they meet Washington's requirements in the Plastic Product Degradability Act (chapter 70A.455 RCW). This would be acceptable for domestic and export markets. It will still be important to monitor progress toward shared standards for compostable product stickers. While Washington considers bans on plastic stickers or requirements for compostable ones, export growers will be the soonest affected by laws going into effect in other countries.

Hazardous or Toxic Substance Content

We must consider each layer of a sticker for potential toxicity including the facestocks, inks, adhesives, and cover plastics. Byproducts of plastic stickers like shreds and microplastics are also important to consider.

Scientific standards like ASTM D6400 have limits on trace elements like heavy metals and toxics that are allowed in compostable products. For fruit stickers, labeling inks are the main source of potential metals and toxics. Even small amounts of ink can make a difference in passing or failing certification.[164]

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[161] Personal communication with Janet Thoman, Compliance Director, Compost Manufacturing Alliance. February 5, 2025.
[162] Washington State Legislature. 2024. RCW 70A.455.040—Requirements for a Product Labeled "Compostable". https://app.leg.wa.gov/RCW/default.aspx?cite=70A.455&full=true#70A.455.040
[163] Zero Waste Washington. 2021. Improving Organic Materials Management in Washington State. May. https://zerowastewashington.org/wp-content/uploads/2021/05/WA-Organic-Waste-Mgmt_Zero-Waste-WA-May-2021.pdf
[164] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

The American (ASTM) standards allow more heavy metals compared to other international standards (see Table 3). This means that stickers certified to ASTM standards may not be acceptable in other countries. This is most relevant for export growers in Washington who need to consider other countries who require certification to standards with lower heavy metal thresholds.

Microplastic contamination in finished compost can come from plastic stickers and stickers without compostable adhesives. Microplastics can harm soil and human health, and they are a detriment to compost facilities who want to make a high-quality product suitable to use for land application.[165] Stickers can also contain chemicals of concern like PFAS that can be present in paper, plastic and some bio-based plastics.[166]

Many bio-based plastic formulations are new relatively untested compared to conventional plastic formulas. Plastics can contain toxics, but as a group they are better known, monitored and controlled compared to bioplastics.[167] Sticker manufacturers recommend that all compostable labels, including paper ones, should adhere to the same standards and testing protocols to affirm their performance, heavy metal contents, presence of PFAS, etc. Manufacturers were adamant that paper stickers be included in any regulatory requirements for compostable stickers.[168]

Print and Application Efficiencies

We need to evaluate produce labeling technologies based on speed, equipment and retrofit efficiencies (where applicable). Efficiency is key when labeling diverse produce types, scaling equipment for variable operations, and altering equipment as needs change.

Any technology considered as a viable alternative to plastic stickers must be on par with the fast pace and international scale of Washington's produce industry. More specifically we looked at the following:

- Keeping less than 5 percent failure rate for labeling,[169]
- Keeping labeling speed or throughput equivalent to plastic PLU stickers, and
- Being able to label diverse types of produce with emphasis on major crops like apples and pears.[170]

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[165] Closed Loop Partners, Composting Consortium. 2024. Don't Spoil the Soil: The Challenge of Contamination at Composting Sites. https://www.closedlooppartners.com/research/compostable-packaging-disintegration-at-composting-facilities/

[166] Compost Now. 2022. PFAS Explained. November. https://help.compostnow.org/s/article/PFAS-Explained

[167] Beyond Plastics. 2024. Demystifying Compostable and Biodegradable Plastics: Do Safe and Sustainable Options Exist? July. https://www.beyondplastics.org/publications/demystifying-bioplastics

[168] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. January 24, 2025.

[169] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. 20 December, 2024.

[170] United States Department of Agriculture, National Agriculture Statistics Service. 2024. 2023 State Agriculture Overview: Washington. https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=WASHINGTON

Sinclair International gave labeling times and throughput numbers for their on-line and pattern labeling equipment, which we wanted to use for comparing other technologies. However, in most cases there was little information on the throughput of non-sticker options. On-line labeling can sticker up to 720 items per minute per lane, with applicators able to run up to 20 lanes at a time.[171] Pattern labelers can sticker whole trays of produce with up to 16 rows per tray and labeling speeds of up to 2,640 trays per hour.[172]

Performance

We asses technology options for how well they communicate needed information and, for stickers, adhesion quality across different types of produce. Fruit stickers serve two main roles in the produce supply chain. They help efficiently track food recalls or food that is causing illness, and they ensure quick and accurate pricing during checkout at retail locations.[173]

Any produce labeling technology must keep needed information legible from the time it gets applied to retail checkout. This means it must work on a variety of produce types with different shapes and surfaces. Stickers must effectively adhere to fruit, and etched or printed marks must stay readable. For Washington, the labeling technology must work on waxy apples and the delicate, oblong-shaped pears. For packing houses, they expect at least 95 percent of stickers to have "good adhesion."[174]

Cost Considerations

Continuing to use plastic stickers (i.e., making no changes) is the least costly option. Compostable stickers can fit easily into existing infrastructure and reduce the need for any major infrastructure changes if more packing houses used them. However, developing new compostable materials and limited production could make compostable stickers more expensive in the early phase. As new options roll out and production increases along with demand, costs could come down in future years. Costs comparisons between compostable and plastic stickers were discussed in Compostable Stickers – Costs and throughput.

For ink-based printing and laser etching, building infrastructure from the start would mean major financial investment. This would be needed for either technology to work at the scale required in Washington. We think these upfront costs make both options infeasible.

Laser etching studies show more bacterial contamination when compared to non-etched produce, which could risk food safety. Additionally, laser etching may lead to shorter shelf lives or laser punctures on produce that affect their quality. We may see more food waste and related costs to manage it.

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[171] Sinclair Systems International. 2025. Sinclair RM6 Technology. https://www.sinclair-intl.com/labeling-systems/on-line-labelers/rm6/

[172] Sinclair Systems International. 2025. Pattern Labelers: Sinclair CR4 Pattern Labeler Technology. https://www.sinclair-intl.com/labeling-systems/pattern-labelers/cr4/

[173] North Carolina State University: NC Growing Together. 2014. Tips for Marketing Fresh Produce to Retail Grocers: Understanding PLU and UPC Codes. https://www.cefs.ncsu.edu/ncgt/understanding-plu-and-upc-codes.pdf

[174] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

Legal and Policy Framework

We looked at existing laws that address produce stickers and other types of labels, and potential legal barriers or policies that might factor into discussions about sticker alternatives.

Stickers are often designed to satisfy the USDA requirement for country-of-origin labeling. Other agencies like WSDA, DOH, and local health districts use PLU information during food recalls to remove items from the marketplace. Without PLU information, it is likely more food would be recalled than necessary. In addition to meeting regulatory requirements, grocery stores rely on PLU stickers for accurate pricing and payment.

Other countries like the EU, South Australia, and New Zealand have passed laws regulating plastic PLU stickers. In the EU, Article 9 of the PPWR of 2024 says all PLU labels for domestic and imported produce must meet EN 13432 standards for industrial composting by 2028.

New Zealand passed legislation for imported produce to have compostable labels under Australian home compostable standards by 2028. Starting in September 2025, South Australia will require compostable labels on all produce (domestic and imported), certified under any compost standard. But in 2028, stickers must meet Australian compost standards (see Table 3).[175]

While Canada does not have proposed legislation, the CPMA agreed to expedite the shift to certified compostable PLU stickers in the interest of international trade and food security. The initiative, backed by composting councils across the world, is designed to create a unified global standard for compostable PLU stickers. This would allow international compost standards to align and possibly enhance recovering organic materials, a critical part of Washington's climate goals.[176]

If Washington chooses to mandate compostable PLU stickers, the ASTM standards used in the U.S. would not guarantee compliance in places with sticker laws like the EU, New Zealand, and South Australia (see Tables 3 and 4). Differing standards impede international trade and are a key point for the international consortium meeting to develop a shared standard.

It will be important for Washington export growers to have access to compostable stickers that meet applicable international standards. As most sticker manufacturers are already preparing to meet international demand in 2028, it is possible that compostable stickers available to Washington growers and packing houses will be acceptable under other country's laws. With the current laws in Washington, we do not expect impacts to produce imports into the state from compostable sticker laws.

[175] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[176] Just Food. 2024. Produce Industry to Develop Standards for Compostable Stickers. October 14. https://www.just-food.com/news/fresh-produce-standard-for-compostable-stickers/

Table 3 – Compost standards comparison chart[177]

	OK Compost INDUSTRIAL and TUV Seedling	EN 13432:2000 EN 14995:2006	ISO 17088:2021 ISO 18606:2013	AS 4736:2006	ASTM D6400-12 ASTM 6868-17
Characterization					
Heavy Metals/Regulation Elements	Same as EN 13432	As, Cd, Cr, Cu, F, Hg, Mi, Ni, Pb, Se, & Zn	Global table with local/regional values	As EN 13432 + cobalt	Reduced list with higher admissible values
Inorganic Materials	Product shall contain a minimum of 50percent of volatile solids				
Biodegradation					
Applicable Standards for biodegradation	ISO 14855-1, -2 EN 14046	EN 14855	ISO 14855-1, -2	EN 14855	ISO 14855-1, -2 Or ASTM D5338
Temperature & Delays	58 ± 2 C, 6 months				
Conversion to CO_2	≥ 90percent absolute or relative				
Biodegradation for constituents	No requirements on constituents present at levels between 1 to 10percent		Constituents at levels between 1 to 10/15percent shall be tested individually		
Non-significant parts	No biodegradation test for non-significant (<1percent) constituents, up to 5percent				
Exemption for materials of natural origin	Yes	EN 13432: Yes EN 14995: N/A	ISO 18606: Yes ISO 17088: N/A	No	ASTM D6400: N/A ASTM 6868: yes
Disintegration					
Applicable standards for Disintegration	ISO 16929 ISO 20200 EN 14045	Not referred in EN 13432 ISO 16929	ISO 16929 ISO 20200	ISO 16929	ISO 16929 ISO 20200
Temperature & Delay	Variable range of thermophilic temperatures for max 12 weeks				
Criteria	<10percent (dry weight) of test material shall fail to pass through > 2 mm fraction sieve				
Visual Contamination	No visual contamination allowed				
Exemption for Equivalent form	Yes	Yes	ISO 17088: No ISO 18606: Yes	Yes	No
Ecotoxicity					
Applicable Standard	OECD 208 modified according to EN 13432 Annex E				
Criteria	Germination rate and plant biomass > 90percent on minimum 100 seeds				
Plant Biomass	2 plant species from 2 of the 3 categories of OECD 208 + summer barley as 4th category		ISO 18606:4 plants (2 from each family)	2 plant species from 2 of the 3 categories of OECD 208 + summer barley as 4th category	
Worm Test?	No		ISO 17088: yes ISO 18606: no	Yes, according to ASTM E1676	No

Table 3 A table comparing composting standards used by different countries across the world. The criteria are similar but not the same.

[177] TUV Austria. 2024. Comparison of Standards for Industrial Compostability. https://okcert.tuvaustria.com/doc-center/

Table 4 – Trace element levels for compostables[178]

Element	U.S. ASTM	Canada ECCC	EU EN	Australia AS	UK EN	Japan	China
Zinc	1400	250	150	150	150	150	150
Copper	750	50	50	50	50	37.5	50
Nickel	210	31	25	25	25	25	25
Cadmium	17	1.5	0.5	0.5	0.5	0.5	0.5
Lead	150	-	50	50	50	50	50
Mercury	8.5	0.4	0.5	0.5	0.5	0.5	0.5
Chromium	-	150	50	50	50	50	50
Molybdenum	-	2.5	1	1	1	1	1
Selenium	50	1	0.75	0.75	0.75	0.75	0.75
Arsenic	20.5	6.5	5	5	5	3.5	5
Cobalt	-	17	-	-	-	-	38
Fluorine	-	100	100	100	100	150	-

Table 4 A comparison of allowed limits of trace elements for compostable products. Limits vary depending on which country's standard is used.

[178] International Composting Alliance and Canadian Composting Council. 2024. Trace Elements Levels for Compostables. Presented at the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.

Evaluation Results

We evaluated produce labeling technologies using research and a review of available data, which in many cases was limited. Interviews helped fill in some gaps where information was not available. The following summaries represent our combined findings from online research, stakeholder interviews, and the follow-up after interviews. We used the decision criteria in the previous section to discuss each technology and included information about the technology's status and potential impacts on key actors.

Compostable Stickers

Compostable stickers are the most feasible alternative to plastic PLUs since options already exist on the market from Sinclair[179] and Elevate[180]. Requiring compostable stickers in Washington would align with international laws with a 2028 deadline and global efforts to create a shared compostable sticker standard. If Washington adopted compostable stickers in 2028 or after, packing houses and farmers would likely benefit from more options. Manufacturers expect to develop new compostable glues and sticker options to meet the needs of international trade and exported produce in the next few years.

While legislation drives demand for compostable stickers, they are a good option for Washington because they fit into most of the existing stickering equipment and infrastructure. There is little retrofitting or technology conversion anticipated except for POD operations.[181]

Packing houses using POD handle many types of produce. A compostable direct thermal sticker option is 3 to 5 years away.[182] This could fit the 2028 timeline in other countries. The POD packing houses may need special consideration if Washington adopts compostable sticker regulations before manufacturers develop an option.

There is still more research and development on compostable adhesives for this technology to be widely available and economically feasible for Washington growers and packing houses.[183] Inks are another opportunity for development.[184] With oncoming laws that require compostable stickers in the EU, Canada, Australia, and New Zealand, manufacturers are focused on compostable options and devoting significant resources toward developing them.[185]

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[179] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[180] Elevate Packaging. 2025. 1.1" Compostable Stickers. https://elevatepackaging.com/1-1-compostable-stickers/
[181] Cohen, R. 2024. Elevate Packaging: Stick to Sustainability, Compostable Produce Labels. Presented at the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.
[182] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.
[183] IFPS, CPMA, ICA, CCC. 2024. Draft Minutes. Sourced from the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.
[184] IFPS, CPMA, ICA, CCC. 2024. Draft Minutes. Sourced from the Global Summit: Compostable Produce Stickers - Finding the Common Ground in Niagara Falls, Canada on October 1, 2024.
[185] Personal communication with Wil Murray, Senior Director of Operations, Sinclair Systems International. December 20, 2024.

Washington packing houses will need to consider stricter standards for compostable stickers in other countries if they export Washington produce. Otherwise, exports could be denied due to non-compliant stickers. It may be prudent for compostable stickers used on Washington produce to meet the strictest standards for exported produce, which currently is EN 13432. Stickers that meet this standard should become more available as 2028 approaches.

Different country's standards will be a factor until there is a shared standard. The international working group of producers, composters and produce manufacturers continue this work. See Table 3 to compare standards from different countries for certifying a compostable product like a sticker.

Laser Etching

Laser etching's advantage to plastic PLU labels is the lack of any external materials since the label is scarred onto the produce.[186] Laser etching is fully compatible with compost processes, adding no known contamination. Reducing plastic contamination at compost facilities seems to be one of the few advantages of laser etching.

Barriers to widespread adoption of laser etching make this technology unlikely as a viable option. There no known laser etching operations or infrastructure in Washington. This suggest a transition to laser etching would disrupt labeling operations and require significant startup costs. Etching does not work on all produce, since thin skins can break create sites where microbes grow. This may risk food safety and quality.[187]

Breaking thin fruit skins makes laser etching unlikely to work with Washington-grown pears, a major crop in the state. Citrus fruits like grapefruit heal over engravings to the point where they become unreadable throughout supply chain processes.[188] Studies demonstrate that etched marks may not work at retail points-of-sale due to insufficient color contrast between the mark and the produce.[189]

Laser etching on apples, Washington's signature fruit, creates significant water loss and microbial contamination.[190] There are also no standard operating protocols for laser etching. We need these for the technology to work on different fruits, as peels can vary in thickness and texture requiring different equipment settings.

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[186] Sood, P. et al. 2009. Laser Etching: A Novel Technology to Label Florida Grapefruit. January. https://journals.ashs.org/horttech/view/journals/horttech/19/3/article-p504.xml
[187] Kachook, O. 2021. Produce Stickers: Are They the Next Straw? May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/
[188] Kachook, O. 2021. Produce Stickers: Are They the Next Straw? May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/
[189] Sree, T.K. and Natarajan, V. 2022. Laser Labeling on Dragon Fruit with Different Codes and their Impact on Surface Characteristics. June 27. https://www.thepharmajournal.com/archives/2022/vol11issue7S/PartBC/S-11-7-619-961.pdf
[190] Khadka, D., et. al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133

There is limited information about labeling times for laser etching on apples,[191] but studies say it is slower than stickering operations.[192] This is another sign that the technology will not work at the needed scale as an alternative. Without more research and development for laser etching, we cannot see it as a viable alternative to plastic stickers. Greene Economics did not find any development efforts place to further develop this technology in Washington.

Ink-based Printing

Ink-based printing has similar advantages as laser etching since it uses only ink to print information. It would reduce plastic at compost facilities. However, we did not find ink-based printing operations in Washington. Key information about using the technology is widely unavailable including the kinds of equipment and ink, labeling times, and throughput numbers. With no known infrastructure in Washington, moving to ink-based printing to label fruit and vegetables would disrupt current operations and bring significant startup costs.

Ink-based printing is not applicable to all kinds of produce. While it works well with smooth skinned fruit like apples, it does not work on rough, fuzzy, or uneven surfaces.[193] With significant gaps in information and only a few previous pilots, ink-based printing is not a viable alternative for PLU stickers. We also did not find any current project or pilots, which may indicate moving away from this technology as an option.

[191] El.En. Laser. 2021. Laser Labeling of Food with Laser Marking. https://elenlaser.com/newsroom/insights/laser-labeling-of-food-with-laser-marking/
[192] Khadka, D., et. al. 2024. CO2 Laser-labeling on Fresh Produce: Evaluating the Postharvest Quality, Microbial Safety, and Economic Analysis. September. https://www.sciencedirect.com/science/article/pii/S0362028X24001133
[193] Kachook, O. 2021. Produce Stickers: Are They the Next Straw? May 12. https://sustainablepackaging.org/2021/05/12/produce-stickers-are-they-the-next-straw/

Comparative Review of Technology Performance

Table 4-3 summarizes technology feasibility based on information gathered through research, as well as that obtained via outreach interviews with key stakeholders. The table compares the various alternative technologies with respect to the decision criteria discussed earlier.

Compostability

Stickers have unique challenges to their compostability. Each layer of a produce sticker must be considered.

Adhesives for plastic PLU stickers are non-compostable. There are limited options for compostable adhesives, and even less for certified options. There are adhesive examples certified to ASTM and EN standards. Compostable adhesives are an active area of research for fruit sticker manufacturers and other compostable product makers.

Paper facestocks can be used for compostable and non-compostable stickers. Paper facestock will break down at most compost facilities but may still bring in chemicals of concern like PFAS. Plastic and bioplastics are also available for stickers. There are several certified compostable options available

Facestocks and adhesives are not used in ink-based printing or laser etching.

Inks are used for ink-based printing and when manufacturing stickers. All inks used must be food-grade. That bodes well for compostability, but there may be some testing needed to ensure ink formulations contain minimum amounts of metals and other elements. Laser etching does not use ink.

Toxicity

Laser etching does not use materials that could introduce toxics, but etched fruit shows more microbial growth. Microbes can make chemicals that produce illness or toxicity in humans.

The food-grade ink used for ink printing has not shown any toxicity, although information is limited.

Plastic stickers shred or ball up and make their way into finished compost. They become visual and microplastic contaminants that pose hazards to human and soil health. Chemicals of concern like PFAS used in plastic and paper formulations can leech into compost during processing. Leeching continues when compost is applied to land.

Certified compostable bioplastics exist and more are coming. Some bioplastic, paper formulations, and adhesives can have new or unknown chemicals. Toxicity or other harms may not yet be known.

Printability

Laser etching works well with some produce. It has not been refined to work on fruit with uneven skin or highly pigmented produce, which affect readability of the marks.

Similarly, ink-based printing does not print readable marks on fruit with uneven or textured skin.

Printability is considered excellent for both plastic and compostable stickers.

Performance

Laser etching and ink-printing vary widely in how they perform. Laser etching can break through thin fruit skins, and thick skins heal over the marks. Etching may lead to more loss as it causes faster spoilage and water loss. Ink marks wash off through the supply chain.

Plastic stickers are the industry standard and must adhere 95 percent of the time. They stay attached to produce and legible at the final point-of-sale. So far, compostable stickers have shown equivalent performance. Manufacturers are using the 95 percent adhesion criteria as they develop new compostable adhesives.

Summary of Findings, Recommendations, and Next Steps

Our results suggest compostable stickers as the only feasible alternative to replace plastic stickers in Washington. Current efforts to ban plastic stickers in places like France, the EU, Canada, Australia, and New Zealand underscore this conclusion. Other alternatives like laser printing and ink printing face too many barriers including their able to scale and meet the needs of growers and packing houses.

Growing interest and awareness about plastic sticker impacts have created a complex and dynamic legislative atmosphere. While using stickers is voluntary, public health officials rely on them to track the source of foodborne illness. Stickers also allow accurate pricing at retailers.

The downside of plastic produce stickers is how they contaminate compost and create pollution. Increasing data on microplastics shows they disrupt ecosystems and impact farmland and fisheries. They can have adverse effects on human health. The small number of sticker manufacturers are developing solutions to improve compostability, reduce toxics, and lower costs.

The discussion in Washington reflects global talks about reducing plastic in the environment and diverting organic materials from the landfill. A key need for compostable stickers adopting and maintaining standards and testing for compostable stickers. This is important to create equal standards for manufacturers and protects farmers, packing houses, and compost facilities.

Testimony during an early version of House Bill 2301 that proposed banning plastic stickers is an example of the parallels. Issues included shared standards to support international trade, readiness of the sticker industry, performance standards, and the impacts to farmers and packing houses. The following section captures the key themes presented by Washington actors related to produce and compostable stickers.

Farmers, Packing Houses, and Distributors

Farmers, packing houses, and distributors agree that produce labeling is critical, and stickers have a smaller impact than bagging or other type of plastic packaging. Being able to maintain existing infrastructure for high throughput is also critical. Alternatives need fit into the existing labeling equipment and meet performance standards to avoid operational cost increases.

There is already concern about higher costs for compostable stickers themselves. This would get passed through to customers who already feel like food costs are high. At least one manufacturer tried to use a hybrid system with plastic and compostable stickers. They paid more to manage the system than they would have to use compostable stickers for everything. As economies of scale improve to meet 2028 European and Australian laws, the price of compostable stickers may come down.

Key impacts

If compostable stickers were required or plastic ones banned in Washington, key impacts would include:

- Higher costs per sticker
- Similar throughput and performance as now
- Packing houses using POD have no compostable option and may need exemption
- Packing houses using POD have no compostable option and would have to convert to pre-printed labels
- Export trade maintained for growers

Sticker and Adhesive Producers

Sticker manufacturers are focused on the 2028 deadline to use compostable stickers in the EU and Australia. Options need to be certified compostable, meet the 95 percent adhesion standard, and pass toxicity limits set by standards in the EU. Manufacturers think meeting global standards and testing scenarios are critical to create a fair market for manufacturers and to protect farmers, composters, and consumers.

While ASTM standards used in Washington are similar to international versions, ASTM has a higher threshold for trace elements like metals. Stickers that meet ASTM standards but not others could cause impact produce sold and shipped abroad.

Manufacturers are a main group involved in the effort to create and adopt international standards for compostable stickers. Their expertise is essential for this work. Other country's laws are driving the timeline and speeding up research and development on stickers to improve compostability, performance, and toxicity. As an example, certifying bodies test for PFAS even though it is not required by ASTM standards.

Industry agrees that PFAS testing is a critical analysis and being proactive while the standards are updated. Manufacturers want all compostable labels, including paper ones, to be subject to the same standards and testing protocols for verifying their performance and components. Packing houses and farmers would have an easier time choosing a product because they are compared to the same standard.

Key impacts

If compostable stickers were required or plastic ones banned in Washington, key impacts would include:

- Buyers and suppliers navigate patchwork of policy
- Continued work on international standard
- Future decisions about adopting an international standard or something else

Compost Facility Operators

In response to Washington's Organic Management Law, compost facilities are preparing to receive more food waste, along with the plastic that often comes with it. Composters make extensive efforts and spend a lot of money to remove bags, service ware, and other plastics, but PLU stickers cannot effectively be removed or screened out. They often end up in the finished compost and the soil after compost is applied. In general, facilities rely on public education and customers to remove stickers.

Because the stickers end up in the finished compost, the compost loses value. While compostable stickers will be more expensive for farmers and packing houses, the cost would be spread along the supply chain instead of entirely in compost facilities.

Composters rely on certification to ASTM standards so they can trust products they receive with incoming food waste. However, these standards have shortcomings when it comes to predicting real performance at a facility. Incorporating field-testing into ASTM standards would help composters more and likely improve their willingness to accept compostable products.

A key question from composters is about approved use on organic farms. The rules do not currently allow compostable plastics to be used to make compost. Plastic stickers are allowed in compost for organic farms if they are under the threshold for incidental contamination. It is unclear the extent that compostable stickers would jeopardize a composter's ability to sell to organic farms. This is a big market for Washington compost facilities. Actors in the industry are petitioning for changes to allow compostable products as a feedstock, but this would require federal rulemaking.

Key impacts

If compostable stickers were required or plastic ones banned in Washington, key impacts would include:

- Less contamination at facilities and in compost
- Compost facilities lose sales to certified organic farms
- Operational costs and changes to accommodate compostable stickers in feedstock

Standards-setting and Certifying Bodies

Standard setting bodies (ex., ASTM) and certifiers (ex., BPI and CMA) play critical roles. Products like compostable stickers are tested against established standards and certified. Certification is important for growers, packing houses, and compost facilities to trust a product.

The ASTM standards are approved, reviewed, and revised by large committees of experts in a consensus process. This structure lets ASTM update standards based on new information and experience brought forward by committee members. The standards in other countries are developed separately. These led to variations in the standards and allowable thresholds across different countries. Differences could trade among nations.

Paper-based stickers also need to be subject to the same testing and certification rigor under the ASTM standards. Such natural materials need to be tested to ensure there are no trace elements or PFAS in the product.

The National Organic Standards Board is another important actor. Their current rules allow incidental amount of conventional plastic in compost, including plastic stickers, but does not allow compostable stickers as an accepted compost feedstock. Certifier BPI proposed changes to allow certified compostables in feedstock for use on organic farms.

Key impacts

If compostable stickers were required or plastic ones banned in Washington, key impacts would include:

- ASTM adds field-testing to complement lab standards for compostable products
- Laws for specific certifications and standards refer to different ones
- Federal consideration to allow compostable stickers in compost on organic farms
- Certifiers may need to look at more standards than just ASTM

Other Jurisdictions

Other countries are banning or restricting plastic PLU stickers. This report is Washington's first step in an ongoing process with many actors. Legislation guides action. In other places like Australia, incremental changes like allowing paper stickers with non-compostable adhesives for a few years are part of the

strategy until more options develop. If stricter requirements pass, the industry will need to catch up. Small incremental changes can facilitate such transitions.

Other international groups like the International Compost Alliance recommends states participate in the international working group rather than developing their own laws. Competing standards and laws make it harder for growers, retailers and distributors to manage.[194]

The group that met in Niagara Falls in October 2024 continues their work on stickers with ongoing workgroups and meetings to discuss standards for compostable stickers and other key issues. Conversations like these are an important way to keep up with ongoing progress during a dynamic time.

Key impacts

If compostable stickers were required or plastic ones banned in Washington, key impacts would include:

- Different laws and standards may hinder trade with other countries
- Compost facilities and customers confused about standards and what is compostable.

[194] Personal communication with Frank Franciosi, Executive Director, US Composting Council. February 18, 2025.

Evaluation of Alternatives

Plastic stickers and each alternative are evaluated and summarized below.

Plastic Stickers

While produce stickers are voluntary Washington, retailers request them to ensure accurate pricing, track growing location, and help with food safety recalls. The USDA requires country-of-origin labeling, which is most often done with PLU stickers. Plastic stickers provide this information with less plastic than bags, bands, and plastic tape.

While plastic stickers are standard for fruit packing houses and grocery retailers, compost facilities cannot remove them, and they end up in the finished product. Organic farms can use this compost, but the stickers are a visual contaminant, which reduces its value. Stickers in compost also add plastic to the soil when compost is applied. With all the negative impacts of plastic in the environment, there is international interest in replacing plastic PLU stickers.

Compostable Stickers

Compostable stickers lead alternatives for plastic stickers. The EU, Australia, New Zealand, and Canada are choosing compostable stickers as a replacement. Washington's current infrastructure can use compostable stickers as is, and there are two sticker producers with certified compostable stickers now.

The price per sticker is higher than plastic stickers, which would likely increase prices throughout the supply chain all the way to consumers. The research driven by international laws that start in 2028 may bring prices down as new options come online and supply increases. The industry is advancing compostable adhesives, inks, and cover films for stickers.

The international group of composters, growers, and sticker manufacturers has been meeting since October 2024 to work on a shared international standard for compostable stickers. This is critical since produce is an international commodity. Sticker manufacturers need to be able to make one product that will work in multiple markets.

Currently EU laws are the most stringent for metals, and manufacturers are using the highest bar for designing products. It is likely manufacturers will make compostable stickers to meet the EU standards, since the stickers will already be compliant in places with less strict requirements.

Laser Etching

Laser etching has no sticker material and does not contaminate compost facilities. But Washington has no established operations, and there is no sign the technology could be used at the necessary scale any time soon.

Concerns about laser etching involve its performance. It cannot create a readable PLU on all kinds of produce and damaging the skin can lead to water loss and microbial growth. For packing houses, it is much slower than stickers. With no infrastructure, laser etching would require a complete infrastructure conversion. Research suggest laser etching is not feasible as an alternative to stickers at this time.

Ink-based Printing

Like laser etching, ink-based printing has no external sticker material that contaminates compost, and Washington has no existing operations. There are doubts this technology could be used at scale.

Ink-based printing shows limited success with smooth produce but washed off throughout the supply chain processes. The markings are especially fragile because only vegetable inks can be used. Ink-based printing would require a complete infrastructure conversion. There also seems little work ongoing to address ink-printing's limitations suggesting it may not be a candidate for others working on this issue. Like laser etching, ink printing is not a suitable alternative to stickers at this point.

Challenges and Data Gaps

There is limited information about alternatives to plastic stickers in research papers, and what is available may not apply to Washington. It is important to confirm the conditions reported through outreach. However, some challenges to our outreach strategy included:

- Limited or no response from key experts including farmers, packers, retailers, and others
- Many could not share information because it is proprietary or has value
- Certain actors were out of scope like retailers and customers.

With these challenges, we could not fill certain information gaps. These include:

Exact locations of packing houses and shipping locations; in Washington
Extensive cost comparisons for compostable stickers and other alternatives
No insight from grocery stores or consumers to understand impacts

Policy Considerations

Washington's policy decisions must support the commitment to diverting organic waste and reducing greenhouse gas emissions. Other goals reducing plastic impacts on compost facilities and the environment, while maintaining as many markets as possible for Washington growers.

Policy might create a phased approach to implement compostable stickers that allows more time for compostable stickers to hit the market and supply improve. Again, most actors recommended states avoid their own regulatory standards until there is a unified standard to adopt. A phased approach allows for certain things to occur that are essential if compostable stickers replace plastic ones, including:

- Compostable sticker options that meet the international standard
- More compostable adhesives
- Labels and equipment for compostable stickers at POD packing houses
- Improved economy of scale for manufacturing stickers to bring down price
- Adopt international standards and make industry players aware, including growers
- Pursue changes to organic agriculture rules that allow for compostable stickers

We also recommend Washington join the conversation about global standards for compostable produce stickers. Most immediately this helps Washington farmers understand the impacts of international actions about stickers that may impact trade. Joining this group would provide access to the most up to date information during a dynamic time.

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Personal communication with Alyson Fick, Staff Manager, American Society for Testing and Materials (ASTM). February 7, 2025.

Personal communication with Ben Barnes, Production Manager, Borton Fruit. March 11 and 12, 2025.

Personal communication with Derek Sorrell, Quality and Sustainability Manger, Accu-Label. February 10, 2025.

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Personal communication with Erin Healy, Director of Standards Division, USDA National Organic Program. February 10, 2025.

Personal communication with Frank Franciosi, Executive Director, U.S. Compsosting Council. February 18, 2025.

Personal communication with Gavin Schmidt, Operations Lead, Dirt Hugger. February 4, 2025.

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Personal communication with Jay Blazey, General Council, Cedar Grove. January 29, 2025.

Personal communication with Jon Devaney, President, Washington State Tree Fruit Association. February 19, 2025.

Personal communication with Keith Mathews, Program Coordinator, Yakima County Horticultural Pest and Disease Board. February 13, 2025.

Personal communication with Kelvin Okamoto, Chair of the D20.96: Environmentally Degradable and Biobased Products Subcommittee, ASTM. February 7, 2025.

Personal communication with Matthew Harris, Director of Government Affairs and Assistant Executive Director, Washington State Potato Commission. December 30, 2024.

Personal communication with Mikey Hanks, Operations Manager, Washington Fruit and Produce Company. February 19, 2025.

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