Evaluating Alternatives to Single-Use Plastics: A Review of Research and Case Studies

FEDERAL POLICY TEAM RESEARCH PUBLICATION

This research publication offers a literature review highlighting several popular plastic alternatives and their pros and cons. It also examines case studies from three countries that intervene to reduce plastic production, as well as incentive and ban ideas for plastic. It proposes that continuing support for these alternatives, along with proper promotion and guidelines, can lead to a more sustainable environment.

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I. Abstract

Plastic pollution has become a significant topic of discussion, as people have become aware of its negative effects. As a result, there have been global efforts to reduce dependence on single-use plastics and transition toward more sustainable materials. There are many options for federal legislation in reducing the scope of the plastic industry. This paper will use existing literature to evaluate alternatives to plastics. Three prominent plastics are highlighted: bioplastics, bamboo, and seaweed. Additionally, there are three case studies that examine how these alternatives have been implemented, as well as incentives and bans, as additional ideas for federal guidelines. The literature review and summary provide strong suggestions for replacing plastics, as well as steps necessary to reach those goals: including addressing cost, public recognition, and having clear guidelines for implementation. The federal government must prioritize implementing plastic alternatives by applying these findings to address existing gaps in cost, public recognition, and regulatory guidance, thereby maximizing their potential to create a more sustainable environment.

II. Introduction

Plastic pollution has emerged as one of the most pressing environmental challenges of the 21st century, prompting a global search for sustainable alternatives. The plastic alternative packaging market is projected to grow from USD 6.11 billion in 2024 to nearly USD 28.89 billion by 2034, reflecting a significant increase in public awareness of plastic's environmental impact and a growing preference for environmentally friendly materials (Precedence Research 2025). This growth in awareness and use of plastic alternatives signifies a potential pathway for a new federal policy to be effective in driving systemic change.

In response to this shift, a range of promising alternatives have gained attention, including bioplastics, bamboo, and seaweed-based materials. Each offers unique environmental advantages but also faces obstacles in size, cost, and adoption.

Effective policy mechanisms, such as tax incentives, expanded plastic drop-off sites, and public recognition programs, can accelerate the transition toward sustainable packaging. Compared with bans and restrictions on single-use plastics, these may also influence the pace and direction of systemic change. This paper examines how a combination of sustainable material innovation and incentive-based policy can strengthen the transition away from single-use plastics and promote a more environmentally responsible economy.

III. Plastic Alternatives

One of the most widely discussed alternatives is bioplastics, which are designed to mimic conventional plastics while reducing environmental impact. Bioplastics are a renewable alternative designed to reduce the environmental harm caused by traditional plastics. Bioplastic polymers are derived from renewable sources such as sugarcane, plant oils, starches, and cellulose. Many other countries, such as India, are shifting from chemical-based industries to sustainable bio-based models to work towards a goal of net-zero carbon emissions (EY 2024).

Bioplastics are considered a sustainable alternative to single-use plastics because of their decomposition process. Bioplastics decompose at a rate similar to other composting materials, but without leaving visible toxic residues. Biodegradable bioplastics are fully degraded by microorganisms without leaving visible toxic remainders (EY 2024).

An additional advantage of bioplastics is their much lower carbon footprint. According to research, the production of PLA plastics (polyester made from renewable mass) requires 1.8kg of carbon emissions, compared to 3.1kg for conventional plastics. This reduction helps mitigate the negative effects of environmental waste. Additionally, the bioplastics highlight a move towards independence and away from dependence on fossil fuels. They're energy-efficient, as bioplastics emit less greenhouse gas and produce no toxins (EY 2024).

Despite these benefits, bioplastics face significant production and regulatory challenges. While it is a sustainable alternative, it costs more than twice as much as traditional plastics. Additionally, the recycling costs of bioplastics are difficult to determine. If bioplastics are not separated from traditional plastics during the recycling process, they can harm the process and affect the quality of recycled items. Another possible downside is the lack of regulation in bioplastics. Many countries have not enacted legislation to regulate bioplastic production, which could lead to

production difficulties. With proper regulation and subsidies, bioplastics could be a strong alternative to plastics and lead to long term societal health (EY 2024).

Bamboo is another sustainable plastic alternative that some populations are incorporating into their economy. Bamboo is an environmentally friendly resource found abundantly in tropical, subtropical, and temperate regions. It spans widely across the Asia-Pacific region. The high availability and overall interest in bamboo have led to it becoming a part of our everyday lives. A very prominent example of this expansion is the use of bamboo straws, which are used regularly throughout the world. Various countries and organizations around the world have sought to reduce the use of plastics and incorporate bamboo into everyday production, including China's domestic policy support for the implementation of bamboo (Li and Sun 2024).

Bamboo provides several environmental advantages. Bamboo is the fastest-growing plant in the world, with a three to five-year time span. This short time span allows for the plants to be harvested quickly. Bamboo absorbs significant amounts of oxygen during its growth, helping mitigate the effects of climate change and global warming. Bamboo degrades naturally and can be recycled for further use. Their maintenance does not require the use of harmful chemicals. Bamboo also carries cultural significance in Asia, particularly China, where it symbolizes resilience. This association has helped bolster domestic policy support for bamboo-based products (Li and Sun 2024).

Some potential downsides are that bamboo's structure is delicate, making it susceptible to cracking. Bamboo's thin and hollow structure makes it more prone to cracking, which can reduce its efficiency in manufacturing. Bamboo also requires a complex growth environment. Difficult harvesting locations, such as hilly or mountainous terrain, could increase harvesting or transportation costs. As bamboo production increases and becomes more well-known to the public, the location and costs of production are potential barriers that should be addressed. One potential solution that the article addresses is automation: having aerial robots that are capable of navigating terrains that is more efficient than manual labor (Li and Sun 2024). Because much bamboo is produced in remote regions of Asian countries, countries like the United States would depend on imports and supply chains, limiting scalability (Jao et al. 2025). However, there is a significant opportunity for large-scale adoption if federal policy supports sustainable

import standards, trade regulations, and infrastructure development. With the right conditions and management, bamboo could become a more prevalent resource worldwide.

Another emerging solution in the shift away from plastics is seaweed-based materials, which offer renewable, biodegradable properties, making them a strong candidate for sustainable packaging. Seaweeds are multicellular, photosynthetic organisms found in all environments. Seaweed grows in saltwater environments and is formed into major groups such as brown, green, and red algae. Their composition enables extraction and processing into biodegradable films, coatings, and packaging (Lomartire et al. 2022). Seaweed can absorb carbon dioxide and nutrients from water bodies, potentially mitigating climate change. Seaweeds are rich in polysaccharides, which allow them to be processed into films, gels, or coatings (Blogpackers 2025). Using seaweed would allow production companies to move away from petroleum as a resource and could generally require less chemical modification or extraction, further exemplifying its environmental benefits (Torrejon et al. 2024).

Despite these advantages, there are potential downsides. Seaweed is costly to produce, making it less accessible for some businesses. In addition to cost, the limited availability makes the item less accessible on the global market. The mechanical performance of seaweed is also a potential issue, as it has lower water resistance and poor barrier performance. Finally, the species-to-species variation in seaweed may make it more difficult to produce. The difference in composition would lead to different production processes for each type, making it a less viable long-term alternative. Therefore, the production of seaweeds faces multiple challenges across the cultivation, harvesting, and production processes (Torrejon et al. 2024). With the right support, seaweed can be a substantial solution to the problem of plastic pollution.

IV. Case Studies: How Various Countries Have Adopted Plastic Alternatives

Evidence from international case studies highlights the role of policy and market dynamics in determining the effectiveness of sustainable alternatives in replacing plastics. In 2023, China's National Development and Reform Commission implemented a "Three-year Action Plan to Promote the Use of Bamboo as an Alternative to Plastic Products to Curb Pollution." The goal of this action plan is to make bamboo a substitute for the industrial plastics system. The country's overall goal is to

govern the effects of plastics and promote the value and importance of eco-friendly products. The plan's six major action objectives include accelerating support measures, enhancing scientific research, encouraging innovation, advancing market mechanisms, strengthening promotion efforts, and consolidating partnership foundations (Li and Sun 2024).

The evaluation of the substitution process, known as "BASP," shows promising marketing potential, as annual demand for market substitutes has been rising. Through the implementation, Bamboo has shown to provide a number of benefits, such as environmental friendliness, natural aesthetics, health benefits, and heat resistance. The choice between bamboo and plastic ultimately depends on environmental impact, economic costs, and production needs. While the market for bamboo has increased, it is still recommended that the government and media channels promote the importance of bamboo and its ability to mitigate pollution (Li and Sun 2024). The successful promotion of bamboo would bolster its success as a plastic alternative.

In Malaysia, government officials are seeking to phase out the use of SUPs and move towards bioplastics. The countries have launched various initiatives, such as the Roadmap Towards Zero Single-Use Plastics. A research study that sought to evaluate and refine bioplastics guidelines in Malaysia conducted Focus Group Discussions (FGDs) to understand stakeholders' views on the current implementation process. These stakeholders were from the public and private sectors and were varied in a way that doesn't show bias towards a sector. The participants reviewed a draft of guidelines to implement bioplastics (Mahadi et al. 2025).

Participants largely agreed that Malaysia's bioplastic guidelines need significant improvement. They agreed that clear, explicit guidelines were an important factor in implementation. The study provided participants with a set of draft guidelines for review. Some of the areas they highlighted for improvement include consistent and well-defined terms, alignment with existing laws and policies, clear procedures for certification and enforcement, and realistic timelines. Other suggestions were also made for the draft, including refining the scope and further specifying the role of enforcement officers. The recommendations from the study reflect an important point as countries begin to implement these guidelines: clear, structured guidelines will bring about these changes more effectively (Mahadi et al. 2025). While there have been no

updates to the guidelines, feedback such as this has fueled a shift towards a stronger, more focused, and safer economy with bioplastics. Having clear guidelines and structure is crucial to the influence and impact of a plastic alternative, such as bioplastics.

A third study examined officials' efforts in Mauritius to phase out the use of plastic bags to protect the environment. Seaweed varieties were tested in Mauritius to evaluate their potential as alternatives to plastic. Since seaweed types can vary significantly, this study focuses on the Gracilaria salicornia and Ulva lactuca species. The study conducted several tests, including a drying test and a water absorption test, to assess its durability and sustainability (Kadell and Callychurn 2023).

The overall findings of the study were that seaweed has material comparable to plastic for use in bags. The seaweed properties are comparable to those of other materials, indicating potential use in the production of eco-friendly, sustainable bags. The use of Ulva lactuca algae specifically showed high tensile strength and water absorption, citing a strong potential as a bioplastic (Kadell and Callychurn 2023). The study shows that the right varieties of seaweed, under the right conditions, can provide a sustainable alternative to plastic.

The three case studies collectively demonstrate the progress select countries have made in implementing plastic alternatives. All three reflected optimism about the success of these materials, yet they differ in approach and focus. For example, China and Mauritius both highlighted the delicate nature of the materials, which affects handling and scalability, but they emphasized different areas for improvement: the China study recommended media promotion, public education, and the use of bamboo, whereas the Mauritius study suggested stronger guidelines and regulatory enforcement. These similarities and differences provide valuable insights for US federal policy, highlighting the potential areas where targeted interventions could be most effective.

The literature review reflects a trend of biodegradable plastic alternatives having strong potential to replace plastics. However, stronger regulations and more public education are needed for the alternatives to reach their potential. Together, these case studies illustrate how clear government guidelines, innovation incentives, and public awareness campaigns can accelerate the transition from plastics to sustainable alternatives.

V. Incentives

Viewing how countries and organizations promote alternatives to plastic use will provide ideas that can be expanded upon at the federal level. Jamaica introduced a Plastic Free Jamaica program to incentivize the use of plastic alternatives by informing youth and citizens about the advantages of these alternatives. The methods of outreach to the Jamaican public include school engagement, visiting local markets, and distributing educational material to younger markets. According to Anthony McKenzie, Director for Environmental Management and Conservation at the National Environment and Planning Agency (NEPA), the efforts have led to a significant reduction in the use of SUPs. Individuals are using less plastic, and local businesses, such as restaurants, are adapting to changes promoted by the Jamaican government (Williams 2025). Based on feedback from the Jamaican government, informative programs such as Plastic Jamaica could have a significant impact on a federal-wide push towards plastic alternatives.

In addition to promoting the positive effects of alternatives to citizens, some companies are awarded and recognized for using eco-friendly alternatives. Eco-labels, for example, indicate that an item meets specific environmental standards. These labels incentivize companies to use eco-friendly materials because customers are increasingly paying attention to environmental friendliness. The labels not only provide this credibility but also create important information and make it easy and accessible for customers to purchase. Having a recognizable badge helps consumers identify environmentally friendly products more easily. These labels provide relevant information, as well as QR codes and links to online sources, which provide details on topics such as carbon footprint, recyclability, and energy efficiency (Carbonbright 2025).

The benefits of eco labels are substantial for both customers and companies. Customers have informed choices, aligning with the values of those who care about improving the environment. These labels also create a positive behavioral influence by promoting environmentally conscious behavior and a healthier environment, and can potentially provide items that are safer for customers to use by containing fewer harmful chemicals. The labels benefit companies by helping them differentiate in the market, stand out from competitors, and build trust among customers. Doing so can also boost their image with investors by positioning them as sustainable and investable, and save money over time by reducing

waste and lowering energy bills (Carbonbright 2025). Real-world examples of positive incentives like these show how federal policy can continue to promote the use of plastic alternatives.

VI. Bans

In addition to incentives, banning plastic use could also promote reducing its use and using plastic alternatives. In Rwanda, the society and government have committed to having clean streets and a green, inclusive, and resilient environment. In 2008, Rwanda introduced a ban of single use plastic bags. They introduced a 60 dollar fine for carrying a single-use plastic bag. Doing so was highly influential in raising public awareness of plastic pollution and in promoting proper waste disposal (GGGI 2023). In addition to passing legislation, the government launches campaigns to raise awareness and educate people about the importance of using alternatives to plastic. The Greenpreneurs Program encourages local companies and entrepreneurs to promote plastic alternatives by providing training, guidance, and support (Ministry of Environment 2025). As sustainable plastic alternatives develop, the success of the plastic ban in Rwanda highlights the option of an outright ban on the federal level.

Canada is another example of a country that created partial bans on plastic use. Beginning in 2022, Canada banned the import and manufacturing of selected items, such as cutlery, bags, and straws. The ban expanded to include the sale of these items, and by December 20, 2025, the manufacture, sale, and import of these items will also be banned. The public largely supports the plastic ban, with 84 percent of women and 80 percent of men in favor. Across all regions of Canada, support for the ban was very high, ranging from 72 percent in Alberta to 92 percent in Quebec. While this ban is a recent development, officials such as Anthony Merante, Oceana Canada's senior plastics campaigner, state that Canada has seen environmental benefits, as the ban has led to systems that are environmentally safe and of good quality. Over time, we can monitor the positive effects the ban has on the environment and residents' knowledge of environmental safety (Recycling Today 2025). Similar to Rwanda, such strong backing of the ban reflects a potential possibility to explore a comparable policy at the federal level.

VII. Conclusion

With rising knowledge of what is environmentally friendly and what isn't, multiple pathways to improving the impact of SUPs have been suggested. By highlighting three popular plastic

alternatives and case studies from different interventions implemented by countries, this paper provides suggestions for how the federal government can work toward a more environmentally responsible country. The evidence from the reviewed literature suggests that plastic alternatives have the potential to reduce the impact of plastic pollution when factors such as cost and popularity are taken into account. Having strong guidelines, media promotion, and education can bolster the plastic alternatives. Supported by incentives and bans, these approaches constrain the potential to transform the nation's relationship with plastics and move towards a much more sustainable, environmentally safe economy.

References

Blogpackers.com. "Why Seaweed Plastic Packaging Is Gaining Attention." blogpackers.com, June 22, 2025. https://blogpackers.com/why-seaweed-plastic-packaging-is-gaining-attention/.

"Eco Labels in Decision-Making Explained." Eco Labels in Decision-Making Explained. Accessed November 21, 2025. https://carbonbright.co/eco-labels-in-decision-making.

An investigation on the use algae-based material for the production of reusable bioplastic bags: A Mauritian case study - sciencedirect. Accessed November 21, 2025. https://www.sciencedirect.com/science/article/pii/S2772397623000345.

Jiao, H., Zhao, T., Wang, Y., Zhao, S., LeBlanc, G. A., An, L., & Wu, F. (2025, September 25). Bamboo's solution to plastic pollution: Feasibility and challenges ahead. New Contaminants. https://www.maxapress.com/article/doi/10.48130/newcontam-0025-0008?utm_source=.

Kadell, M. Y. Z. K., & Callychurn, D. S. (n.d.). An investigation on the use algae-based material for the production of reusable bioplastic bags: A Mauritian case study - sciencedirect. Science Direct. https://www.sciencedirect.com/science/article/pii/S2772397623000345.

Li, Xiaohua, and Huayu Sun. "Bamboo Breeding Strategies in the Context of 'Bamboo as a Substitute for Plastic Initiative.'" MDPI, July 6, 2024. https://www.mdpi.com/1999-4907/15/7/1180.

Lomartire, Silvia, João C. Marques, and Ana M. M. Gonçalves. "An Overview of the Alternative Use of Seaweeds to Produce Safe and Sustainable Bio-Packaging." MDPI, March 18, 2022. https://www.mdpi.com/2076-3417/12/6/3123.

Mahadi, Zurina, Emirul Adzhar Yahya, Mashitoh Yaacob, Wardah Mustafa Din, Ahmad Firdhaus Arham, and Nur Asmadayana Hasim. "Toward National Guidelines for Biodegradable and Compostable Bioplastics: A Case Study in the Federal Territory of Kuala Lumpur, Malaysia." Polymers, August 8, 2025. https://pmc.ncbi.nlm.nih.gov/articles/PMC12389128/.

Plastic alternative packaging market size to hit USD 28.89 bn by 2034. Precedence Research. (n.d.). https://www.precedenceresearch.com/plastic-alternative-packaging-market.

Recyclingtoday.com. Accessed November 21, 2025. https://www.recyclingtoday.com/news/oceana-canada-poll-shows-support-for-single-use-plastics-ban/.

"Rwanda Launches National Circular Economy Action Plan and Roadmap." Ministry of Environment. Accessed November 21, 2025. https://www.environment.gov.rw/news-detail/rwanda-launches-national-circular-economy-action-plan-and-roadmap.

"Rwanda: Lessons Learnt from a Pioneer in the Fight against Plastic Pollution." GGGI. Accessed November 21, 2025. https://gggi.org/rwanda-lessons-learnt-from-a-pioneer-in-the-fight-against-plastic-pollution/.

TM incentivising bioplastics, a biopolymer: A move towards a circular and. Accessed November 21, 2025. https://www.assocham.org/uploads/files/Incentivizing%20Bioplastics_3%20Sep_digital.pdf.

Williams, Sherika. "Plastic-Free Summer Campaign in Progress." Jamaica Information Service. Accessed November 21, 2025. https://jis.gov.jm/plastic-free-summer-campaign-in-progress/.

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