

# Sustainable Packaging Solutions for Dairy Products: Balancing Environmental Impact and Consumer Preferences

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## Abstract

The dairy sector encounters significant obstacles in shifting from traditional packaging materials to more eco-friendly alternatives, given the perishable nature of dairy products and widespread reliance on non-biodegradable packaging. Nonetheless, there's a rising interest in sustainable packaging solutions to curb carbon emissions and waste. This paper examines the intricate interplay between environmental effects and consumer preferences in dairy packaging. It explores various material choices like compostable packaging and biodegradable plastics, as well as innovative concepts such as smart packaging and plant-based materials. Despite challenges like limited infrastructure and financial constraints, there are opportunities for innovation and collaboration throughout the supply chain. Key steps toward achieving sustainable dairy packaging include investment in research, partnerships with packaging suppliers, and utilizing consumer insights. Consumer preferences for convenience, affordability, and product freshness, coupled with growing environmental consciousness, highlight the importance of addressing sustainability in dairy packaging. Transparent labelling, effective marketing, and advancements in materials and technologies offer promising avenues for reducing environmental impact while meeting consumer demands. Collaboration and innovation are vital for navigating the complexities of sustainable dairy packaging and contributing to a greener future while ensuring product quality and consumer satisfaction.

## Introduction

The high nutritional value of milk and its derivatives makes it difficult to store them for an

extended period of time and makes the process of handling them more difficult. Dairy products are included in the category of highly perishable foods because they provide a good medium for the growth of microorganisms, especially bacterial pathogens, which can result in food deterioration and consumer illnesses. Several studies have demonstrated that packaging plays a significant role in the protection of dairy products once they have been manufactured. Packaging can efficiently extend the shelf life of these items. The widespread use of plastic bottles, cartons, and containers in the dairy business substantially contributes to the excessive amount of trash produced by packaging. As environmental concerns continue to develop, there is a growing interest in discovering environmentally friendly packaging solutions that reduce carbon footprints and waste to the greatest extent possible. In order to achieve sustainability in dairy packaging, however, it is necessary to give careful consideration to a number of different elements, such as the selection of materials, the production methods, and the preferences of consumers. Within the context of dairy product packaging, this essay investigates the intricate relationship that exists between the impact on the environment and the preferences of consumers. Properly packaging milk is crucial not only for preserving its nutritional value and reducing waste, but also for creating a more marketable product to increase returns. Delivering nutritious milk to consumers in the most cost-effective, hygienic, secure, and environmentally friendly packaging possible is a challenge that the packaging industry must face.

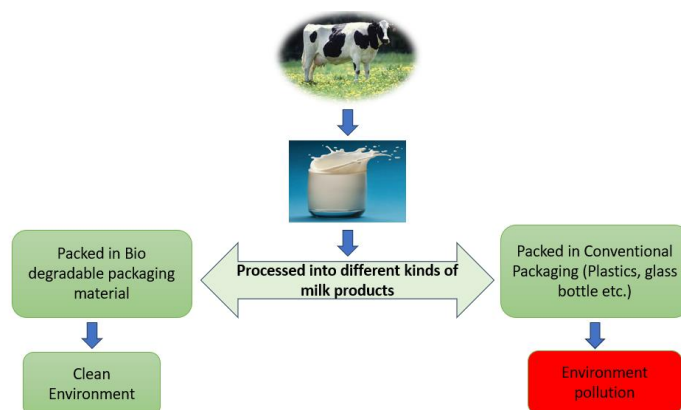
**Material Options and Environmental Impact:** Conventional dairy packaging, like bottles, cartons, and containers, has notable environmental drawbacks

due to its non-biodegradable nature, posing challenges for recycling and raising concerns about environmental impact and potential chemical contamination. Moreover, these packaging methods often lack advancements in convenience and freshness preservation. In contrast, compostable packaging offers an eco-friendly solution by utilizing materials that naturally decompose in compost settings, lessening landfill burden and pollution. Compostable packaging brings various environmental benefits, including waste reduction, lower carbon emissions, and reduced dependence on finite resources (Rejeesh and Anto, 2023). Some dairy companies have successfully embraced compostable packaging, as seen in the case of Company X, which transitioned its yogurt products to such packaging, yielding positive environmental outcomes and heightened consumer satisfaction. Nevertheless, the widespread adoption of compostable packaging encounters obstacles, such as the higher cost of compostable materials, insufficient composting infrastructure, and concerns about packaging durability and shelf life. Despite these challenges, there are opportunities for industry innovation and collaboration to surmount these barriers and advocate for sustainable packaging practices.

In the dairy industry, traditional packaging materials like plastic and glass have been predominant due to their durability and cost-effectiveness. However, concerns about their environmental impact, particularly plastic pollution and greenhouse gas emissions, have prompted manufacturers to explore alternative materials that offer similar functionality with less environmental harm. Biodegradable plastics derived from renewable sources like cornstarch or sugarcane are gaining traction as an eco-friendlier option. Additionally, plant-based packaging materials made from bamboo or bagasse offer another biodegradable alternative to conventional plastics. Fig. 1 shows the Impact of biodegradable and conventional packages on environment.

Regulatory authorities overseeing food safety have urged food companies to reduce the presence of chemicals and microorganisms in food products. This, coupled with consumer demand for natural,

preservative-free, and long-lasting products, has driven the food industry to innovate in packaging concepts. For extending the shelf life of milk and milk products, a proven effective method involves combining Modified Atmosphere Packaging (MAP) with refrigeration. Carbon dioxide (CO<sub>2</sub>) gas, a natural antimicrobial agent, helps inhibit the growth of certain microorganisms (Singh et al., 2012).



**Fig. 1 Impact of biodegradable and conventional packages on environment**

Cutting-edge ideas and materials transforming the dairy business include reusable containers, plant-based materials, and compostable packaging. Businesses are setting standards by implementing these solutions. For instance, some companies utilize naturally derived films or coatings, such as seaweed or starch, that are edible and can be consumed along with dairy products, eliminating the need for traditional packaging. Establishing a sustainable culture involves collaborating with local communities to develop innovative solutions tailored to their specific needs and preferences.

### Consumer Preferences and Market Trends

Convenience, cost, and product freshness are key factors influencing consumers' purchasing decisions, alongside the rising importance of sustainability. The wooden barrel is thought to have originated between 300 and 350 BC, around the same period when glass started to gain popularity. Liquids were exchanged and stored using these kinds of packaging. The invention of fluid milk packing in the current era dates back to 1856, when Gail Borden discovered and patented the method for condensed milk. The glass milk bottle was created in 1884, the automatic bottle filler and capper was created in 1886,

and the first paper milk carton with plastic coating was created in 1932 (Karaman et al., 2015). Therefore, the success of environmentally friendly packaging solutions in the dairy industry depends on their ability to meet diverse consumer demands. To educate consumers and build trust in sustainable packaging, clear labelling and communication of environmental benefits are crucial. Effective marketing strategies emphasizing the positive impacts of sustainable choices can also boost demand and encourage wider adoption of eco-friendly packaging. The market for smart packaging is expected to grow from 2017 to 2025, driven by factors such as increasing consumer health consciousness (Mirza Alizadeh et al., 2021). Present-day consumers are increasingly aware of health risks associated with toxic materials in traditional packaging, particularly in food packaging. The safety and hygiene of smart packaging make it a preferred choice among consumers. The global smart packaging market is segmented into North America, Europe, Asia-Pacific, and the rest of the world.

### Challenges and Opportunities

The dairy sector encounters various hurdles when striving to shift from conventional packaging materials to more environmentally friendly alternatives, despite the increasing demand for sustainability. Infrastructure limitations, such as inadequate facilities for processing or disposing of eco-friendly packaging, can pose significant barriers. Financial considerations also play a crucial role, as transitioning to sustainable packaging often requires upfront investments in new materials, technology, and production processes, which may strain budgets, especially for smaller dairy businesses. Additionally, technical challenges, such as finding suitable materials that maintain product freshness and integrity while meeting environmental standards, can hinder progress. Nevertheless, these obstacles present opportunities for innovation and collaboration within the industry. Dairy companies can leverage these challenges to drive creativity and develop novel solutions that address both environmental concerns and practical packaging needs (Scetar et al., 2019). Collaborating with suppliers, research institutions, and other stakeholders across the supply chain can

foster the development of sustainable packaging solutions tailored to the dairy industry's specific requirements. By pooling resources and expertise, companies can overcome technical limitations and accelerate the adoption of eco-friendly packaging.

Investing in research and development is crucial for overcoming technical barriers and advancing sustainable packaging technologies. By dedicating resources to exploring alternative materials, refining production processes, and improving packaging designs, dairy firms can develop innovative solutions that meet consumer expectations for both sustainability and product quality. Furthermore, cultivating partnerships with packaging suppliers who specialize in eco-friendly materials can provide access to expertise and resources needed to implement sustainable packaging practices effectively. Additionally, leveraging consumer data and market insights can guide dairy companies in understanding consumer preferences and expectations regarding sustainable packaging. By aligning their packaging strategies with consumer values and preferences, dairy firms can enhance brand reputation, build consumer trust, and drive demand for eco-friendly products.

### Conclusion

The dairy industry faces significant challenges in transitioning from conventional packaging materials to more environmentally friendly alternatives, despite the increasing demand for sustainability. However, these challenges also present opportunities for innovation and collaboration within the industry. By investing in research and development, forging partnerships with packaging suppliers, and leveraging consumer data, dairy companies can overcome obstacles and drive progress towards sustainable packaging solutions. Consumer preferences for convenience, cost-effectiveness, and product freshness, alongside growing environmental concerns, underscore the importance of addressing sustainability in dairy packaging. Clear labelling and effective marketing strategies can help educate consumers and promote the adoption of eco-friendly packaging options. Moreover, advancements in materials and technologies, such as biodegradable

plastics, plant-based materials, and smart packaging, offer promising avenues for reducing environmental impact while meeting consumer needs. To navigate the complexities of sustainability in dairy packaging, it is essential for industry stakeholders to collaborate and innovate. By working together to develop tailored solutions that balance environmental responsibility with practical packaging requirements, the dairy sector can contribute to a more sustainable future while maintaining product quality and consumer satisfaction.

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