

EXECUTIVE SUMMARY

Preserving the Food Chain

Lead Analyst: **Harini Venkataraman, Ph.D.**

Contributors: **Sara Olson, Ph.D.**

Joshua Haslun, Ph.D.

Thomas Hayes

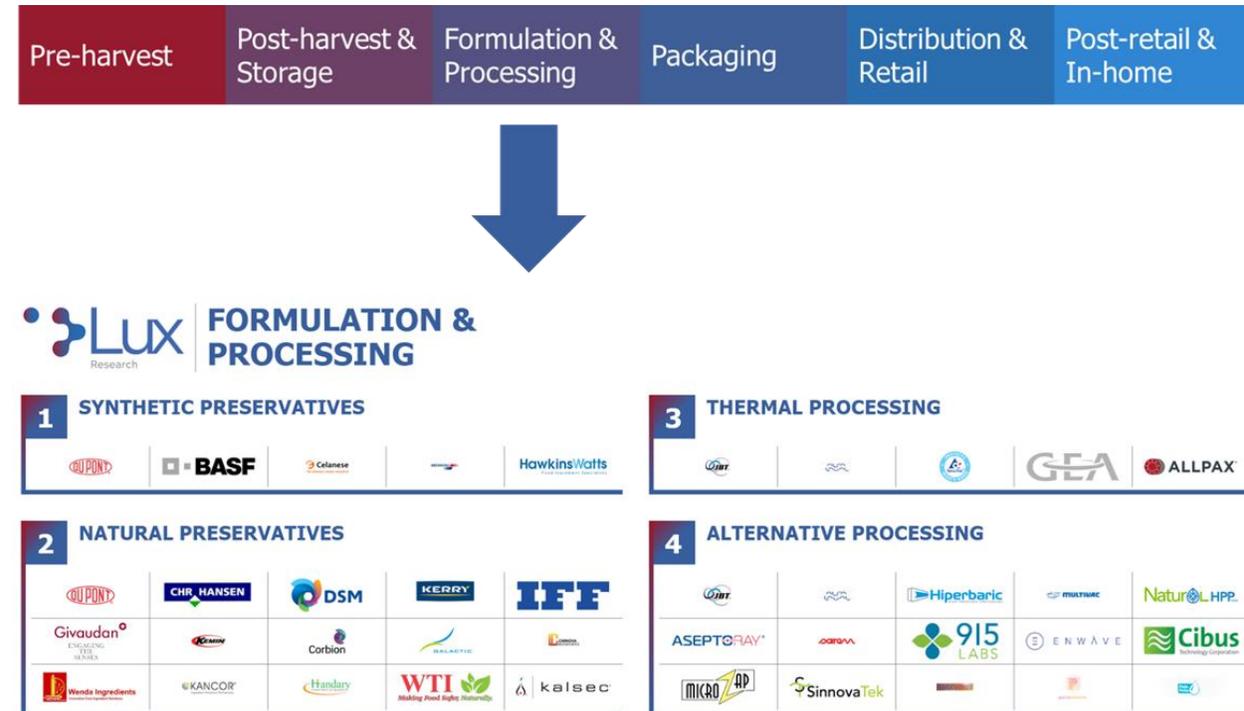
Laura Krishfield

Executive Summary

Protection and preservation technologies form a key piece of the puzzle of combating food loss and waste, a pressing issue contributing to significant financial losses, especially in times of supply chain disruptions or demand variability.

Given the growing innovation interest, in this report, Lux analyzes how preservation technologies can play a major role in various segments of the value chain and highlights key players and opportunities spanning these segments.

Improving food supply chain resiliency and building consumer trust will be even more important in a post-COVID-19 global economy, and companies need to take a tech-driven approach to address this. Companies should act now to partner with key developers or invest in preservation technologies to prepare for the future needs of the agrifood industry.

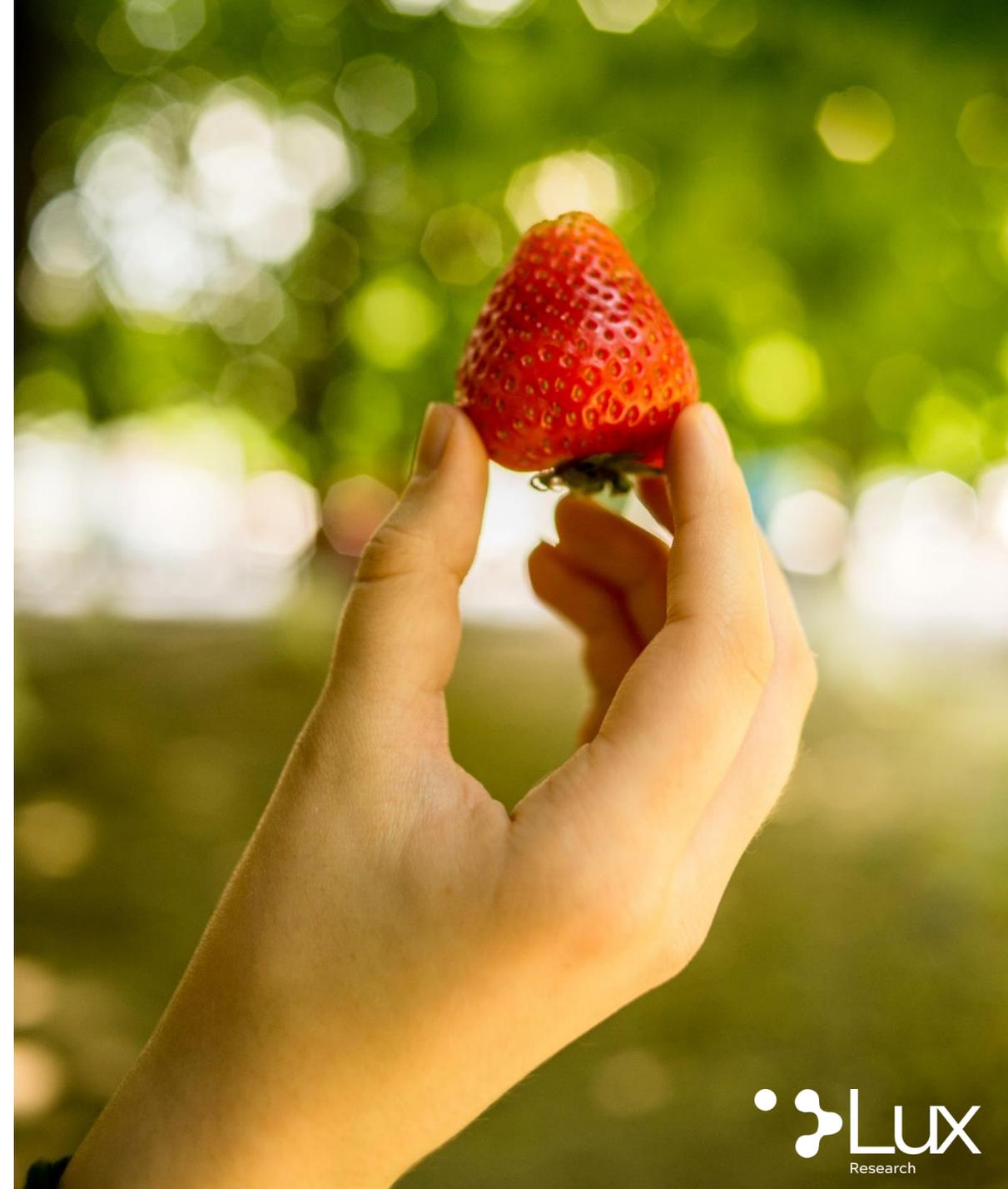


Why is preservation important?

With more than [1.3 billion metric tons of food](#) waste generated every year, food loss and waste (FLW) is a major global problem. In terms of economic losses, this translates to a whopping \$1 trillion loss around the globe.

Beyond financial concerns, FLW represents a humanitarian crisis, contributing to both short-term and chronic food security concerns worldwide. The U.N. has set a [goal of global sustainability by 2030](#) concerning FLW. Governing bodies around the world, including in the [EU](#) and the [U.S.](#), have come up with action plans to achieve this goal. To this end, **protection and preservation technologies** will form a key piece of FLW prevention and achieve significant improvement in value chain resiliency.

The unprecedented global crisis due to the COVID-19 pandemic has put a focus on resiliency in the food value chain, which calls for effective, technology-driven approaches to tackle the FLW problem from farm to fork.



Lux Tech Signal

The Lux Tech Signal is based on our analysis of innovation data including:

- Patents
- Academic papers
- VC funding
- Government funding
- Lux proprietary data

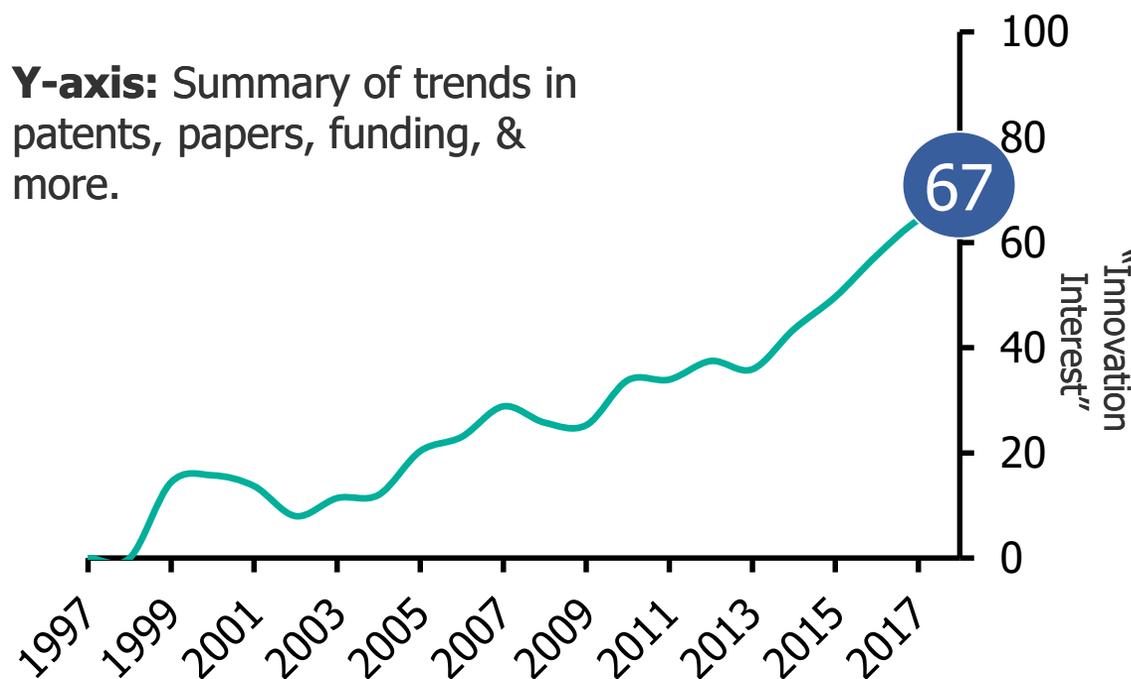
The **Innovation Interest** score is calculated by analyzing multiple, diverse datasets weighted based on our evaluation of the role innovation sources play in each stage of commercial technology development, empirically tested and validated against real-world historical data.

The maximum possible score is 100, indicating the highest observed rate of research, patenting, funding, etc.

Innovation interest for protection and preservation technologies is on the rise



Y-axis: Summary of trends in patents, papers, funding, & more.

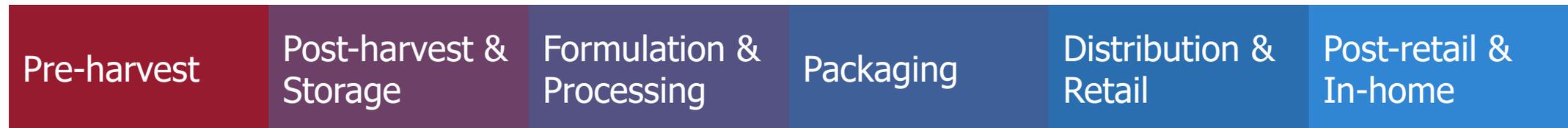


Preservation is key across the agrifood and health ecosystem: This report focuses on the food supply chain

Preservation and shelf life extension are relevant concerns for any perishable product and for any product whose quality or efficacy declines over time in storage or under non-ideal conditions. This has been recognized in the pharmaceutical and pesticide industries for a long time, where innovations like cold chain management and shelf life-extending formulations have been well-developed.

More recently, promising innovations have been developing across the food supply chain, from pre-harvest technologies to those that apply to post-retail and in-home storage scenarios. This report will focus on the segments shown below, highlighting the most relevant technology options for preservation in each segment.

Importantly, think of these segments as parts of a spectrum rather than discrete pieces; the relevant technologies in each segment will blend somewhat into the segments preceding and following it. When considering these options, focus on resiliency in your supply chain against fluctuating supply and demand.



PACKAGING

Needs and Technologies

Active packaging solutions to combat physical, chemical, or biological processes leading to food spoilage are in high demand. Continuous monitoring of the environmental conditions and quality attributes of food products throughout the supply chain is necessary for temperature-sensitive food products.

EXISTING AND EMERGING TECHNOLOGY OPTIONS

Technology	Description
Modified atmospheric packaging (MAP)	Adjusts atmospheric gas content, including carbon dioxide, oxygen, and nitrogen levels, to optimize product shelf life
Active packaging	Packaging materials containing agents that promote shelf life extension by absorbing or emitting certain volatiles, controlling moisture levels, or reducing microbial activity
Smart packaging	Sensor-enabled intelligent packaging enables continuous tracking and monitoring of products

TRENDS IN THIS SPACE

While technologies like MAP have been used to help extend shelf life and prevent spoilage, developers are looking beyond passive MAP, including adopting active packaging methods, which are more advantageous to control respiratory metabolism of fruits and vegetables.

Promising developments include academic research projects like EU-funded NanoPack, which has focused on flexible plastic food film with antioxidants and antimicrobial properties to delay food spoilage. Sensor-enabled smart packaging solutions are gaining importance for tracking the quality of perishable food products, with digital connectivity as a catalyst for the growth of these solutions.

LUX | ACTIVE AND SMART PACKAGING
Research

1 OXYGEN SCAVENGERS

2 CARBON DIOXIDE SCAVENGERS AND EMITTERS

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3 ETHYLENE SCAVENGERS AND EMITTERS

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4 ANTIMICROBIAL AGENTS

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5 MOISTURE CONTROL AGENTS

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6 SMART PACKAGING

LUX TAKE

Mainly dominated by large companies and SMEs, active packaging solutions are relatively mature, with limited startup activity to consider for open innovation efforts. Startup activity in sensor-enabled smart packaging is gaining momentum, with startups focusing on incorporating freshness indicators and time-temperature indicators to track perishable food products. Clients should aggressively vet potential solutions for the real cost-in-use of novel approaches and focus on solving verified unmet needs.

Summary of protection and preservation technologies along the value chain

Pre-harvest	Post-harvest & Storage	Formulation & Processing	Packaging	Distribution & Retail	Post-retail & In-home
Synthetic pesticides	Post-harvest fungicides	Synthetic preservatives	Modified atmosphere processing	Cold chain monitoring	Point-of-use sensing
Coatings	Ethylene scavengers	Natural preservatives	Active packaging	Food retail supply chain management	Smart packaging
Biopesticides	Post-harvest coatings	Thermal processing	Smart packaging	Refrigeration	Smart appliances
Pre-harvest fungicides	Post-harvest storage	Alternative processing		Packaging solutions	Storage

Through a series of case studies spanning the value chain, we help identify technology-based partnering and open innovation strategies for players in the food value chain to develop and benefit from preservation technologies.

CASE STUDY: PACKAGING

Partnering to integrate antimicrobial packaging solutions



INTRODUCTION AND BUSINESS IMPACT

Parx Plastics develops a zinc-based material to create antimicrobial plastics called "Saniconcentrates" for a number of applications, including food packaging. These antimicrobials can be added to single- or multilayer food packaging films. Parx previously partnered with Turkish packaging company [Erze Ambalaj](#) as well as retail store [Aldi U.S.](#) In December 2019, Parx announced a partnership with PepsiCo to develop antimicrobial solutions for high-performance plastic packaging.

KEY PLAYERS



LUX TAKE

Although antimicrobial food packaging is of great interest, its commercial activity has been limited over the years. When incorporating antimicrobials into food packaging, optimal performance in food contact is important. As Parx's active material mixed with the plastic does not leach, it claims a long-lasting antimicrobial effect, making it an interesting option. PepsiCo's collaboration with Parx will likely leverage this property for its existing packaging solutions.

Outlook

The myriad preservation technologies and their applications across the food supply chain open the door to reduced losses and increased profit margins for players across agrifood.

While traditional preservation methods will continue to help drive value, the penetration and adoption of biological and digital tools will play an important role in shaping the future of preservation tech, be it digital solutions for crop protection in the pre-harvest stage, sensor-enabled smart packaging solutions, or efficient demand forecasting and inventory management in the retail segment.

Clients must actively pursue opportunities to deploy preservation technology solutions for meaningful business impacts. Focus on the technology evolutions listed to the right initially, as these will be the most impactful changes in preservation tech in the coming three to five years.

What's in store for the coming three years?

Pre-harvest

Integrated crop protection methods will become industry-standard

Post-harvest & Storage

Waxes will lose dominance to a mix of bio-based coating solutions

Formulation & Processing

Biopreservation methods will gain performance parity with conventional methods

Packaging

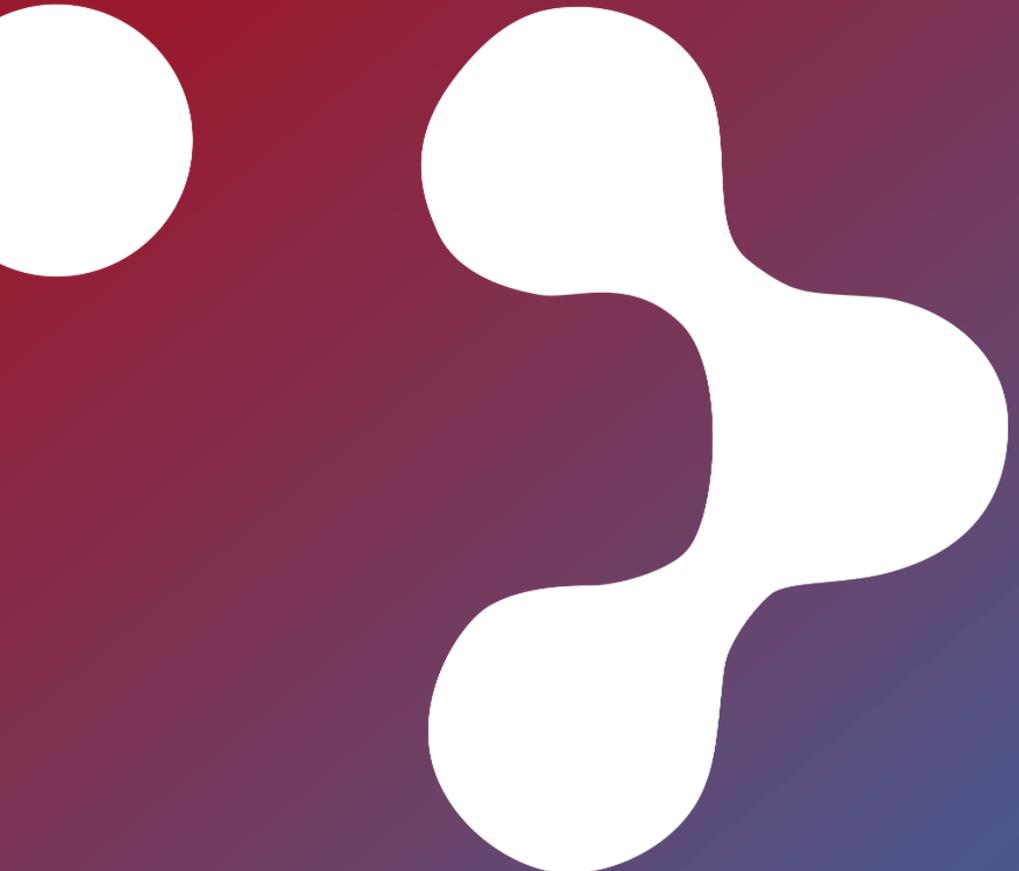
Antimicrobials will dominate active packaging developments

Distribution & Retail

Adoption of digital tools will increase, driven by supply chain management

Post-retail & In-home

Smart appliances will get smarter, but POU sensors will flourish



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