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Agricultural Utilization Research Institute

**FINAL REPORT FOR MORE SUSTAINABLE
PACKAGING SOLUTIONS TO IMPROVE
CONSUMER CONFIDENCE IN GROUND BEEF**

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FINAL REPORT FOR MORE SUSTAINABLE PACKAGING SOLUTIONS TO IMPROVE CONSUMER CONFIDENCE IN GROUND BEEF

ABSTRACT

This research identifies and evaluates more sustainable packaging options that improve consumer confidence by providing tangible and consumer-visible demonstrations of the beef industry's commitment to reducing its carbon footprint. The basis for developed concepts came from prior research, global review, value chain needs, and the availability of more sustainable packaging. In consumer attesting, all tested concepts were perceived as more sustainable than the current package despite life cycle analysis evidence to the contrary on four of the six tested concepts. Consumers also indicated that package color and the use of a *Freshness indicator* can positively influence their perception of package sustainability and ability of the package to reduce waste.

Research outcomes specifically indicate opportunities to:

- Improve consumer sustainability perception of the current overwrapped Expanded Polystyrene (EPS) tray package with a kraft color scheme
- Improve consumer sustainability perception of the current overwrapped EPS tray package format with clear on package communication to share the sustainability story of EPS tray and how its foam structure results in less plastic as compared to non-foam rigid plastic trays
- Improve consumer sustainability perception of the current chub package format with clear on package communication to explain minimal use of packaging
- Assess and implement alternative packaging formats that better communicate sustainability to consumers

As a result of this research, the investigators recommend the following additional work:

- Develop an on-pack communication strategy that effectively conveys the sustainability attributes of the chosen package format
- Assess and implement alternative package formats that not only better communicate sustainability to consumers, but also *purposefully decrease food waste*
- Conduct research linking package sustainability metrics to food waste and industry sustainability efforts, in an effort to inform the on-pack comprehensive sustainability communication strategy

PROBLEM DEFINITION AND PROJECT RATIONALE

The rationale for this research relies upon the Beef Industry Lifecycle Assessment¹⁴, which identified “future opportunities to further increase sustainability” through packaging alternatives and reductions in food waste. The beef industry has experienced significant success in focusing on nutrients, efficiency, and production aspects that have decreased the environmental impact of beef^{1,6}. However, there is an opportunity to better connect with consumers on sustainability using more effective packaging^{1,2,3}. Sales of food products perceived as “more sustainable,” such as plant-based foods, are on the rise, while retail sales of beef are *projected* to decline⁵. To retain existing and attract new consumers, the beef industry needs to better communicate its sustainability gains to consumers. More sustainable packaging is a vehicle that can effectively convey these sustainability gains to consumers. The project focused on case-ready fresh ground beef products because they represent a sizable opportunity within the chilled red beef category.

OBJECTIVE

This research consisted of three objectives:

1. Identify and determine more sustainable packaging options that communicate beef sustainability to consumers
2. Improve consumer confidence in beef through the identification and refinement of more sustainable packaging options
3. Guide the consumer-first messaging of more sustainable packaging to enable an increase in beef demand

METHODS

This research employed 3 methods: Concept Development, Consumer Testing, and Concept Environmental Impact Profiling.

1. Concept Development Concepts were developed used the following inputs:

a. Prior Research

Prior research was reviewed to develop design constraints and ensure more sustainable packaging solutions aligned with what is known from ground beef consumers and on sustainability. Two primary pieces of research were employed. The first was “Ground Beef Package Design Analysis” supplied by the Minnesota Beef Council, and the second was a review of literature on consumer testing and research associated with consumer views on more sustainable packaging.

b. Meat Category Expertise & Global Review

Packaging Technology and Research (PTR) has prior experience with meat category project work sponsored by ReFED, a multi-stakeholder nonprofit committed to reducing U.S. food waste, focused on identifying category-specific, more sustainable packaging solutions with technical insights on barrier, distribution, retail, and material recycling facility needs. PTR expertise in developing more sustainable packaging strategies for

food companies was applied. Finally, conducting a global review of meat packaging enabled an applicability assessment of these solutions to Minnesota ground beef packaging.

c. Value Chain Needs Assessment

An assessment of needs was conducted at each point in the value chain from production to the consumer.

d. Sustainability Attributes (Material selection and end of life treatment)

More sustainable packaging options were assessed from sourcing (recycled or bioderived content) and disposal (recycling, composting, landfill, incineration) viewpoints

- 2. Consumer Testing:** Twenty-five Minnesota consumers assessed concepts to gauge their perception of the concept's sustainability credentials. In addition to the concepts, consumers gauged the influence of color and the use of a generic *Freshness indicator* (of which specific executions are commercially available, though the specific execution was not explored in this research) on their sustainability perception. Note that, as a result of the COVID-19 pandemic, remote, instead of in-person, testing was employed to generate consumer feedback. This deviated from our original work plan and maybe a source of error.
- 3. Environmental Impact Research:** Concepts were assessed for environmental impact using PIQET's Life Cycle Assessment software (an industry-standard) to determine the actual environmental impact of all package concepts in comparison to the current overwrapped EPS tray package. Life Cycle Assessments generated data on each packages' impact on climate change, water use, land use, and ozone depletion. Concept variations included the measurement of recycled content paperboards and polymers. The combination of Consumer and Life Cycle Assessments highlighted the connection between consumer perception and actual environmental impact.

RESULTS

1. Concept Development:



- a. Prior Research: Summarized data comprised a list of "must-have" package requirements presented as a publication by the investigators in this project (Reference 4).
 - b. Meat Category Expertise & Global Review: This review indicated that more packaging material is used in meat packaged outside the United States, with remarkable region to region consistency. This aligns with a more complex view of sustainability globally, including a higher incidence of recycling in the EU and other high-income countries. Notably, the United States remains the only high-income country that has not yet connected the environmental cost of packaging to manufacturers through an *Extended Producer Responsibility* (EPR) program. Concept development focused on current domestic perceptions of paper versus plastic as well as reducing the visibility of plastic in each concept.
 - c. Value Chain Needs Assessment: This assessment included each stage of the value chain (Manufacturers, Retailers, Consumers, Collection, and Sorting) according to
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source reduction (using less packaging), recyclability, bioderived or recycled content, and compostability. Recyclability and recycled content were significant considerations for retailers, municipalities, and finished goods manufacturers, leading to the assessment of concept variables employing varying levels of recycled content in addition to recyclability of the concept itself.

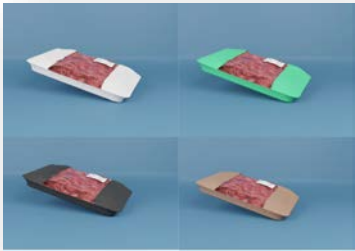

- d. Sustainability Attributes (Material selection and end of life treatment): More sustainable sourcing was refined to include recycled content and bioderived polymers that are in commercial use today. More sustainable disposal focused on recycling, as many compostable concepts are not commercially viable today or within five years

2. Consumer Testing: Six viable, more sustainable packaging concepts were developed for consumer feedback. These concepts are profiled in Table 1.

Table 1. More sustainable packaging options developed for consumer sustainability perception.

Concept Description	Photo
<p>Paper Tray with Paper-Plastic Overwrap</p> <ul style="list-style-type: none"> • The package is composed of a paper tray and a clear plastic and paper overwrap that seals on the bottom • The plastic film is not made with recycled content, nor is it recyclable or compostable • The paper tray is recyclable or compostable • Users can place extra ground beef on the tray and the tray base folded over and then resealed with overwrap • Variations include a recycled content tray and a recycled or bioderived content overwrap 	
<p>Chub with Paper-Plastic Overwrap</p> <ul style="list-style-type: none"> • The package is composed of a paper-plastic wrap with a tear strip for opening and a reseal feature • The paper-plastic wrap is not made with recycled content, nor is it recyclable or compostable • Ground beef is divided into 4 portions as shown by the sections on the paper-plastic wrap • Ground beef is removed by peeling the tear strip on the paper-plastic wrap • Extra ground beef can remain within the chub pack and the paper-plastic wrap folded over and sealed with the resealable tape • Variations include recycled or bioderived content overwrap 	

<p>Clear Tray with Mesh Overwrap</p> <ul style="list-style-type: none"> • The package is composed of a clear plastic tray and a clear plastic mesh overwrap sealed with a resealable tab to the bottom of the tray • The plastic tray is not made from recycled content but is recyclable • The package opens by peeling back the resealable tape on the tray and pulling it over the top of the meat • Ground beef is divided into 4 portions as shown by the 4 indents on the tray base • Extra ground beef can be placed on the tray and the tray base folded over and then sealed with the resealable tape • Variations include recycled or bioderived content tray and overwrap 	
<p>Card with a Skin Pack</p> <ul style="list-style-type: none"> • This package contains 1 pound of fresh ground beef • The package is composed of a clear plastic wrap on a paper-based card • The wrap is not recyclable or compostable, but the paper card is recyclable or compostable • The package opens by separating the paper card from the plastic wrap • Variations include recycled content card and recycled or bioderived content overwrap 	
<p>Chub-in-a-Box</p> <ul style="list-style-type: none"> • The package is composed of a clear plastic wrap within a paper-based box • The plastic wrap is not made with recycled content, but the paper box is made with recycled content and is also recyclable or compostable • A consumer accesses the ground beef by opening the paper box and then unwinding the overwrap around the meat • Extra ground beef can remain within the pack and the overwrap folded over and resealed • Variations include recycled content carton and recycled or bioderived content overwrap 	
<p>Minimized Plastic Bag</p> <ul style="list-style-type: none"> • The package is composed of a clear plastic bag • The plastic bag is not made from recycled content and is not recyclable or compostable • The package opens by breaking the seal and untwisting the twist tie at the top of the bag • Extra ground beef can be resealed within the bag using the twist tie • Variations include recycled or bioderived content bag 	

<p>Colors</p> <ul style="list-style-type: none"> • Where options were viable, colors were assessed in connection with Consumer views on sustainability • Colors assessed included white, green, black, and uncolored (“kraft” or “natural color”) 	
<p>Freshness Indicator</p> <ul style="list-style-type: none"> • A <i>Freshness Indicator</i> was assessed for its connection to package sustainability and value • The concept assessed represents a generic construct a consumer may use to understand the ground beef’s remaining shelf life 	

Twenty-five Minnesota consumers evaluated all concepts across several metrics to gauge their perception of each concept’s eco-friendliness. Results indicated that consumers felt all concepts are “eco-friendlier” than the current overwrapped EPS tray package. Additionally, consumers ranked the concepts, in order from more sustainable to less sustainable, below:

1. Paper Tray with Paper-Plastic Overwrap
2. Clear Tray with Mesh Overwrap
3. Chub-in-a-Box
4. Chub with Paper-Plastic Overwrap
5. Card with a Skin Pack
6. Minimized Plastic Bag
7. Current EPS Tray Package

When presented with uncolored (kraft paper color) versions of package concepts, 83% considered uncolored (kraft paper color) as the most sustainable. Consumers stated they would pay an average of \$1.00 more for the *Freshness indicator* for one pound of ground beef.

3. **Life Cycle Assessment:** The current overwrapped EPS tray package incorporates a significant volume of air into the tray, thus lowering its environmental impact. As a result, only two concepts had a lower environmental impact than the current package (presented in Table 2).

Table 2. Life cycle analysis results of more sustainable packaging concepts. Note that the current overwrapped EPS tray package is the first concept on the left.

LCA data	LCA metric Climate Change (milliCO eq)	17.76	31.32	51.17	8.86	40.47	29.30	7.75
	LCA metric: Water use volume (L H ₂ O)	2.59	2.10	4.78	0.53	2.75	2.00	0.49
	LCA metric: Land Use Impact (g C Deficit)	7.48	104.54	31.65	11.67	133.29	250.00	3.28

ANALYSIS AND CONCLUSIONS

Interestingly, consumer perception of more sustainable packaging did not align with actual environmental impact (as measured through the Life Cycle Analysis (LCA) protocol presented in Table 2).

Below are the key takeaways on the six concepts perceived to be *more sustainable* by consumers:

- a. Two were factually (via LCA) more sustainable in terms of Climate change
- b. Four were factually (via LCA) more sustainable in terms of Water use
- c. Consumers perceived the current overwrapped EPS tray package to be the least eco-friendly, although it had the third lowest actual water impact.
- d. Consumers perceived the **Paper Tray with Paper-Plastic Overwrap** to be more eco-friendly, and it has a low water impact.
- e. Consumers perceived the **Minimized Plastic Bag** and **Chub with Paper-Plastic Overwrap** concepts to be the third worst eco-friendly concepts, despite having the lowest water impact.

The additional options explored indicated that consumers perceived the uncolored (kraft or natural color) package to be more sustainable even without material changes. And finally, the *Freshness indicator* adds value to the package and connected with consumers as a means to improve food safety, thus reducing meat waste.

ACTIONABLE ROADMAP AND RECOMMENDATIONS

This research is usable for:

1. **Improving consumer perception of current package sustainability with color:** 83% considered uncolored (kraft paper color) as the most sustainable color. The use of recycled content lowers the LCA Water and Land use environmental impact. Increasing recycling rates decreases all LCA impacts. Value Chain research showed that recycling and recycled content resonates with consumers and that Retailers are seeking partners for store drop-off recycling

2. **Improving consumer perception of sustainability of Current Chub package:** While LCA data show that the Current Chub package has a low environmental impact, consumers do not perceive this package as sustainable. The Chub has a much lower environmental impact than the current EPS tray package in addition to minimizing issues with freezer burn and thawing associated with the overwrapped EPS tray package. Updating the Chub's consumer appeal in the dimensions of quality and sustainability is an opportunity to provide more factually sustainable packaging that consumers actually believe is more sustainable. Strategies to increase consumer perception of sustainability for the Chub package include:
 - i. Assess directional use of recycled paper as part of the existing overwrap to decrease the environmental impact while increasing the perception of sustainability
 - ii. Assess options for portioning markings or embossing on Chub as portioning correlates positively with sustainability perception
 - iii. Assess *Freshness indicators* to add to Chub package value since consumers perceive the Chub to be of poor quality

3. **Improving consumer perception of sustainability of Current EPS Tray package:** While LCA data show that the Current Tray package has a low environmental impact, consumers do not perceive this package as sustainable. Strategies to improve the perception of sustainability for the Current Tray package include:
 - i. Explore Value Chain linkages to increase recycling rates of Polystyrene
 - a. Advocating for curbside recycling of Polystyrene
 - b. Advocating for store drop-off of recyclable Polystyrene along with flexible packaging
 - c. Advocating for the use of recycled Polystyrene by the meat industry
 - d. Assess opportunities to enable a closed-loop (or circular) Polystyrene system
 - e. Assess the efficacy of implementing a means (color, labeling, etc.) to communicate the use of recycled Polystyrene
 - ii. Assess graphics, labeling, etc. to explain the high air content of Polystyrene
 - iii. Assess consumer perception of sustainability of colored Expanded Polystyrene or, alternatively, Expanded Polyethylene
 - iv. Assess directional use of recycled paper as part of the existing overwrap to decrease

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- v. Assess options for portioning markings on overwrap or tray as portioning correlates positively with sustainability
 - vi. Assess Freshness indicators to add package value as consumers indicated they would pay more for this benefit, thus offsetting a perceived lack of package value associated with its poor sustainability perception

4. Assessing and implementing alternative packaging that connects with consumers on sustainability

- i. Decrease visually large unbroken areas of plastic
- ii. Conduct in-person or In-Home-Use Test package prototypes with Paper Tray with Paper-Plastic Overwrap, Clear Tray with Mesh Overwrap, Chub with Paper-Plastic Overwrap

Recommended Future Research:

- 1. Develop an on-pack communication strategy that effectively conveys the sustainability attributes of the chosen package format. Conduct research on:**
 - i. Package information and style (fonts, text, colors, wording) and how it relates to sustainability
 - ii. Actual shelf life and use of a “Consume-Within” Freshness indicator (CWI)
 - iii. Define an effective on-pack portioning strategy, as this correlates positively with consumer perception of sustainability
 - iv. Assess means to create a Minnesota specific beef package with a more sustainable on package story
- 2. Assess and implement alternative package formats that not only better communicate sustainability to consumers, but also purposefully decrease food waste.**
 - i. Follow-up on consumer perception of food waste prevention for the top three packages from this research
 - ii. Conduct in-person or In-Home-Use Test with refined versions of Paper Tray with Paper-Plastic Overwrap, Clear Tray with Mesh Overwrap, Chub with Paper-Plastic Overwrap
- 3. Conduct research linking package sustainability metrics to food waste and industry sustainability efforts to inform the on-pack communication strategy.** This would align with the United Nations Strategic Development Goal 12 N SDG 12, linking food and packaging waste and thereby establishing the benefits of protecting meat with superior packaging.

The authors of this report propose more sustainable packaging to reduce food waste as a Phase 2 follow-up of this initial project. Food waste in America is a massive \$48.5 billion challenge. The reduction of beef waste is a critical component in solving the food waste problem, as 30% of food waste is comprised of meat. The high consumer value of beef indicates that consumers value packaging that reduces food waste. Previous research indicated that packaging solutions might reduce beef waste by 16% for consumers and 7% for retailers ^{7, 8, 9}. Furthermore, packaging innovations to reduce waste can add more value to the beef supply chain, increase beef shelf life, and expand distribution networks. The output of this second phase of research will identify, assess, and fine-tune options to sustainably decrease case-ready fresh ground beef waste in the packaging value chain.

For a detailed review of the methodologies employed and results generated, please view the supplementary presentation located here: https://youtu.be/B91u6-R_8dl.

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About AURI

The Agricultural Utilization Research Institute's mission is to foster long-term economic benefit through value-added agricultural products. It accomplishes this by using science and technology to help develop new uses for agricultural products. It partners with businesses and entrepreneurs to generate economic impact in Minnesota communities by helping businesses take advantage of innovative opportunities in four focus areas: biobased products, renewable energy, coproducts and food. AURI provides a broad range of services, including applied research and development, scientific assistance and a targeted network of resources to develop value-added uses for crops and coproducts.

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About PTR

Packaging Technology and Research (PTR) focuses on food packaging science and value chain initiatives to achieve a more sustainable food system. This involves more sustainable packaging that prevents food waste. PTR has led cross-functional efforts, pinpointed technology and value chain solutions, built compelling business technology strategies, and generated implementation roadmaps for the packaging and food industry since 1996.

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