

Improved Sustainability in Fresh Beef Packaging to Prevent Food Waste in a Meaningful Way for Consumers Final Report

FOOD WASTE PREVENTION AND MORE SUSTAINABLE PACKAGING

Research coordinated by the National Cattlemen's Beef Association, a contractor to the Beef Checkoff and the Minnesota Beef Council.

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Abstract

This phase 2 project identified more sustainable packaging options for consumers to prevent ground beef food waste and analyzed how these findings can assist in effectively communicating future sustainability goals for the beef industry. Qualitative and quantitative focus groups were conducted with 16 ground beef package prototypes and nine messaging claims. A phase 1 project conducted in 2020, which recommended completing this phase 2 project, measured the life cycle impact of packaging alternatives to polystyrene trays and overwrap and provided quantitative research on consumer perception and “willingness to pay”.

The results from this project showed that food visibility overruled sustainability and food waste concerns with packaging. There is a “sweet spot” aligned with packaging reduction and consumer preferences for a resealable clear vacuum-sealed packaged pouch. There was a secondary connection between portioning and food waste. Improving understanding of spoilage indicators on the quality of meat intended to purchase will lead to less ground beef being wasted at retail. There was a strong connection between intelligent packaging and food waste. Finally, there is an opportunity to link recycled content and recyclable packaging with sustainability. A RoadMap highlighted specific directions in three areas, each on ground beef food waste prevention and more sustainable packaging. Ten follow-up research projects were defined based on the results from this study.

Problem Definition and Project Rationale

The completed phase 1 project (2020) represented the first time Minnesota Beef Council (MBC) funded a project on more sustainable packaging. Findings from the phase 1 report can be referenced in Appendix A. Phase 2 extends this work into the realm of enhanced sustainability in packaging and reduction of ground beef food waste, primarily focusing on refined messaging to consumers. This work will continue to increase consumer confidence in purchasing beef products, demand for animal protein and demonstrate industry leadership on sustainability efforts and goals.

Objective

The primary objective of this project was to determine how to communicate (on physical prototype packaging) messages to consumers around sustainable packaging and packaging that prevents ground beef food waste. This study builds on a completed phase 1 project that identified more sustainable packaging options for case-ready ground beef.

Methodology

A three-step process methodology was used in this research to achieve the desired project objective and purpose.

Step 1. Identify Key Packaging Elements

Key package elements that communicate food waste reduction and sustainability were identified by project investigators and isolated from phase 1 by utilizing industry meat packaging expertise. The identified elements were intelligent packaging, reliability, portioning, reduction in plastics and alternative packaging formats (Figure 1).

Figure 1. Packaging Elements Identified



















Sustainability messaging relating to more sustainable packaging included sourcing and disposal of packaging. These elements were then used to define prototype parameters.

Step 2. Construct Prototypes

Sixteen prototypes (Figure 2) that mimic current packaging consumers purchase and use in their households were developed and included:

- Resealability
- Portioning
- Reduction in plastic
- Alternate packaging formats
- Alternate packaging materials

Figure 2. Prototypes Evaluated by Consumer Focus Groups

1a	PS tray + overwrap		3c	Paper tray + paper-plastic overwrap	
1b	PS tray + overwrap with portioning		4a	Clear resealable pouch	
1c	PS tray + paper-plastic overwrap		4b	Clear resealable pouch with portioning	
2a	PET tray + overwrap		4c	Clear resealable pouch + paper backing	
2b	PET tray + overwrap with portioning		5a	Brick pack	
2c	PET tray + paper-plastic overwrap		6a	Butcher paper wrap	
3a	Paper tray + overwrap		6b	Clear butcher wrap	
3b	Paper tray + overwrap with portioning		6c	Paper-plastic butcher wrap	

Nine prototype messaging elements (Figure 3) that align with prototype materials were developed and printed to mimic labels consumers see in retail stores. These messaging elements were used to assess disposal understanding of post-consumer packaging. Consumer connections to food waste, sourcing more sustainable packaging material and disposal alternatives were assessed from the prototypes.

Figure 3. Messaging Prototypes Elements





Disposal



Intelligent Packaging Shelf-life cues



The 16 prototypes were aligned to messaging so that prototypes were only labeled with appropriate messaging. For example, the resealable pouch with a handle and brown paper layer were assessed with:

- Shelf-life Cue: Intelligent packaging
- Sourcing: Percent less packaging, percent less plastic, bioderived, percent recycled content
- Disposal: Compostable

297 prototype samples were created for focus group participants to handle packaging as they would in grocery and retail stores and at home. Packaging prototypes contained 80/20 ground beef that was packaged at the Agricultural Utilization Research Utilization (AURI)'s federally inspected Meat Laboratory at the Southwest Minnesota State University (SMSU) campus in Marshall, Minnesota.

Step 3. Qualitative and Quantitative Research and Analysis

Consumer focus group testing of prototypes by 36 participants was conducted in August 2023 at the AURI Marshall Sensory Laboratory office at the SMSU campus. The 90-minute focus group process included a ranking of prototype groups, presentation of ground beef prototype packaging, and the ability for focus group members to physically handle the packages. Participants ranked packages based on their preferences and provided comments on each packaging sample throughout the focus group session. A focus group talk track was developed in advance to guide discussion, referenced in Appendix B.

Results and Conclusions

The analysis explored consumer perceptions in the context of more sustainable packaging and ground beef food waste prevention. The analysis was conducted using the transcribed videos of each session. For clarity, results are divided by Food Waste Prevention and More Sustainable Packaging.

Food Waste Prevention | Intelligent Packaging

- Respondents' initial reactions to intelligent packaging were positive, with one respondent interrupting the moderator and saying, "I want that" and "this adds value because I would know meat quality."
- Retail was the most critical location for Intelligent Packaging. Consumers liked/preferred the connection to lower prices at retail if ground beef was in the "yellow zone" (use or freeze in 3 days) or even lower red zone (use or freeze in 1 day) since they could freeze the meat.
- Intelligent packaging could raise confidence in meat quality from a non-local store. Sample comments below:
 - "If the price is lower, I would buy red" (use within 1 day)
 - "Might be helpful at a Walmart vs local store since I worry about meat at Walmart."

However, respondents indicated that more information on how intelligent packaging functions is needed:

- Consumers wish to be educated on the display, intent and purpose of intelligent packaging.
- Consumers saw little value in using intelligent packaging sticker after purchase, commenting that they would freeze the meat after purchase.
- Intelligent packaging does not replace the need to see the quality of the meat.

- Consumers want both a date code and intelligent packaging to use the oldest meat first in their freezer.

In the final ranking, 83% of consumers ranked intelligent packaging stickers as the top choice when considering other stickers that noted packaging content/type and source (less packaging, less plastic, recycled content, bioderived) and disposal process options (recycling, composting).

Food Waste Prevention | Resealability and Portioning

Adding a reseal feature to a package improved consumer ranking. Adding a portioning feature to pouches was also well received.

More Sustainable Packaging | Reduction in Plastic

Ground beef packaged in smaller plastic and vacuum packaging was perceived by focus groups to be of higher quality. Meat purchased was commonly designated for a planned meal. In this context the needed quality of the meat was assessed and the inability to see the meat reflected poorly on meat quality that could likely increase food waste due to poor meat quality. Thus, meat packaged with opaque paper elements was not well received. Consumers were not willing to trade paper packaging, which they believed was more sustainable than plastic, for the ability to see the product. Product in packaging containing paper or paperboard was perceived to be of lower quality. Packaging that was clear on all sides was ranked at the top within each package type. Thus, opaque paper trays and pouches were perceived to contain lower-quality meat due to the perceived inability of paper to protect the meat. Further, consumers trusted plastic, not paper, to keep products fresh and did not want to “take the risk” of buying meat of unknown condition.

Interestingly, the 2020 phase 1 project findings indicated that consumers viewed packaging as more sustainable if the plastic was not contiguous on the package and was broken up by a “stripe” of paper. However, in phase 1, consumers participating in the focus groups assessed packaging remotely due to COVID-19, and in phase 2, could physically handle the packaging prototypes and see the packaged ground beef in person versus over a computer screen. Results from this study identified that plastic replacement with paper was not perceived as more sustainable or viewed favorably by consumers for all packaging formats (trays, resealable, and non-resealable pouches).

More Sustainable Packaging Formats and Materials | Alternate Packaging Formats

Consumers consistently ranked pouches ahead of tray packaging only when pouches were portioned in a vacuum pack or when the pouches had a resealable feature. This infers that switching to packaging that reduces plastic in beef packaging needs to have added consumer benefits.

Messaging on More Sustainable Packaging | Sourcing

Consumers connected well with materials and packaging that were sourced from recycled content. Specific feedback was that the exact recycled content was “not needed” on the package and that there were no issues with recycled content in contact with meat. Consumers connected sustainability to vacuum-packaged pouches that had less plastic than other formats. Less petroleum-derived plastic and bioderived packaging did not seem to resonate with consumers.

Messaging on More Sustainable Packaging | Disposal

Consumers connected with materials and packaging that could be recycled. If packaging was not recyclable, it was perceived as not sustainable. When consumers were told that the polystyrene (PS) tray (PS has the lowest value in Life Cycle Impact analysis) had less plastic, consumers were not swayed. Sample comments:

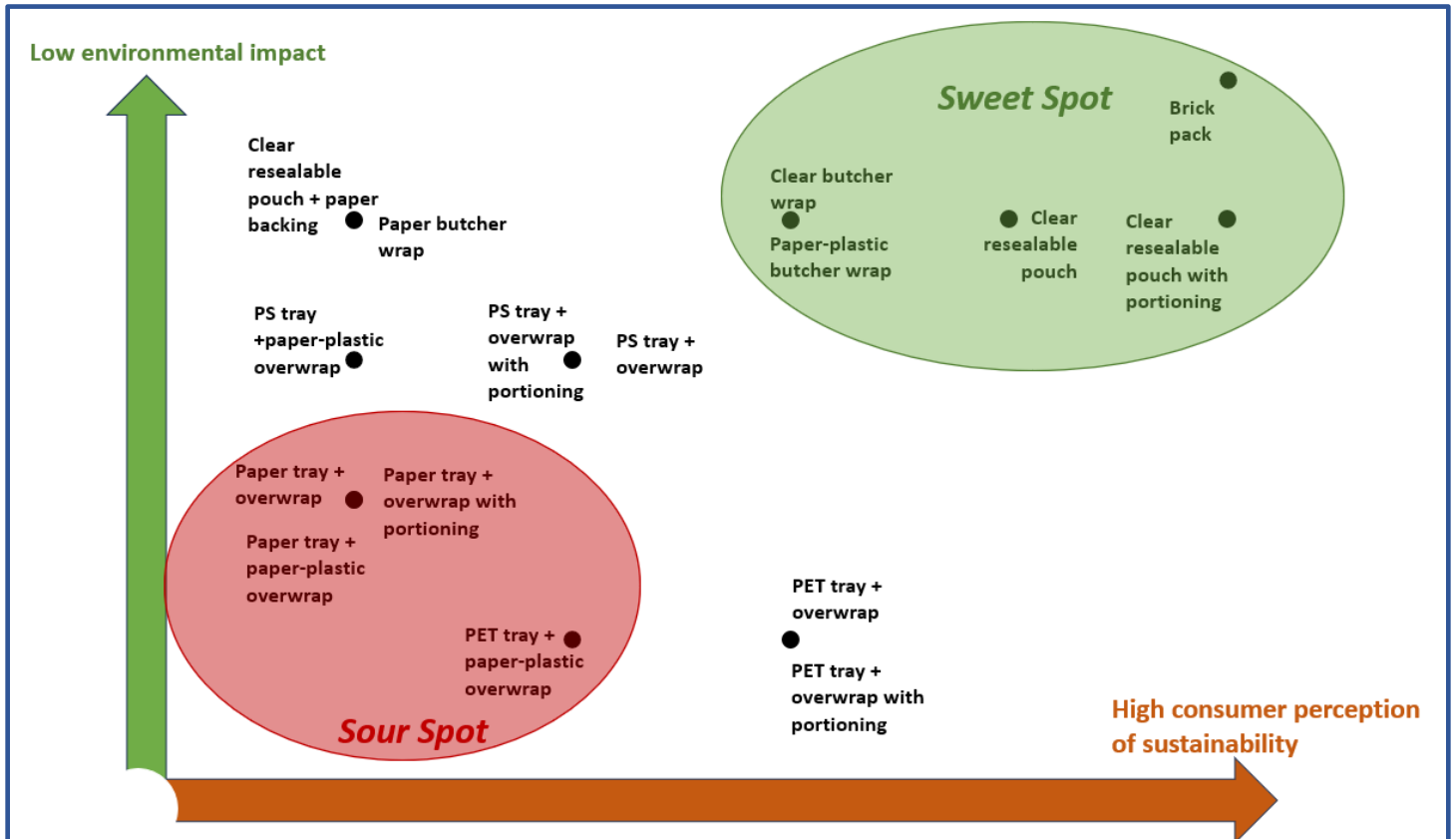
- “Even if there is less plastic, I still feel like this is something I should not be using.”
- “Even if there is less plastic, since foam cannot be recycled, it is not good.”

Consumers indicated “would never take back store drop off (SDO) recyclable meat flexible packaging, since it would be too difficult to rinse clean and the packaging would smell.” Consumers were confused by compostable packaging that “they cannot bury in the backyard” and noted “it is deceiving.”

Interaction between Consumer Perception and Environmental Impact



The “Sweet Spot” category had the lowest environmental impact and the best consumer perception and represents the packaging that connects with consumers on sustainability and is actually more sustainable. These packages resonate with consumers on sustainability and are more sustainable. The “Sweet Spot” category is the pouch format. Pouches that were vacuum packed, resealable, and/or divided into portions scored the highest within the pouch format. Interestingly, the lower environmental impact is largely due to less packaging material being used and less packaging results represents a lower cost for packaging. Packages within the “Sweet Spot” also represent lower cost packaging that those in the higher environmental impact category. The scoring of various package types on environmental impact and consumer perception are shown below in figure 4.

Figure 4. Interaction between Consumer Perception and Environmental Impact








The “Sour Spot” category had the highest environmental impact and the lowest consumer perception. This packaging does not connect with consumers on sustainability, is less sustainable, and thus should be avoided. The “Sour Spot,” where the packaging is less sustainable and liked less, comprised the paperboard tray and PET trays with paper wrapping.

Figure 5.

PET tray + overwrap	PET tray + overwrap with portioning
	

There was also a misalignment on the paperboard and PET trays' environmental impact. The trays actually have both the worst environmental impact score and best consumer sustainability perception. This packaging might appear as "greenwashing" since it can look more sustainable while being less so. These packages are shown below. Further, consumers will likely be confused by the sustainability claims of packaging within the lowest environmental impact / high consumer sustainability perception category. These packages are shown below.

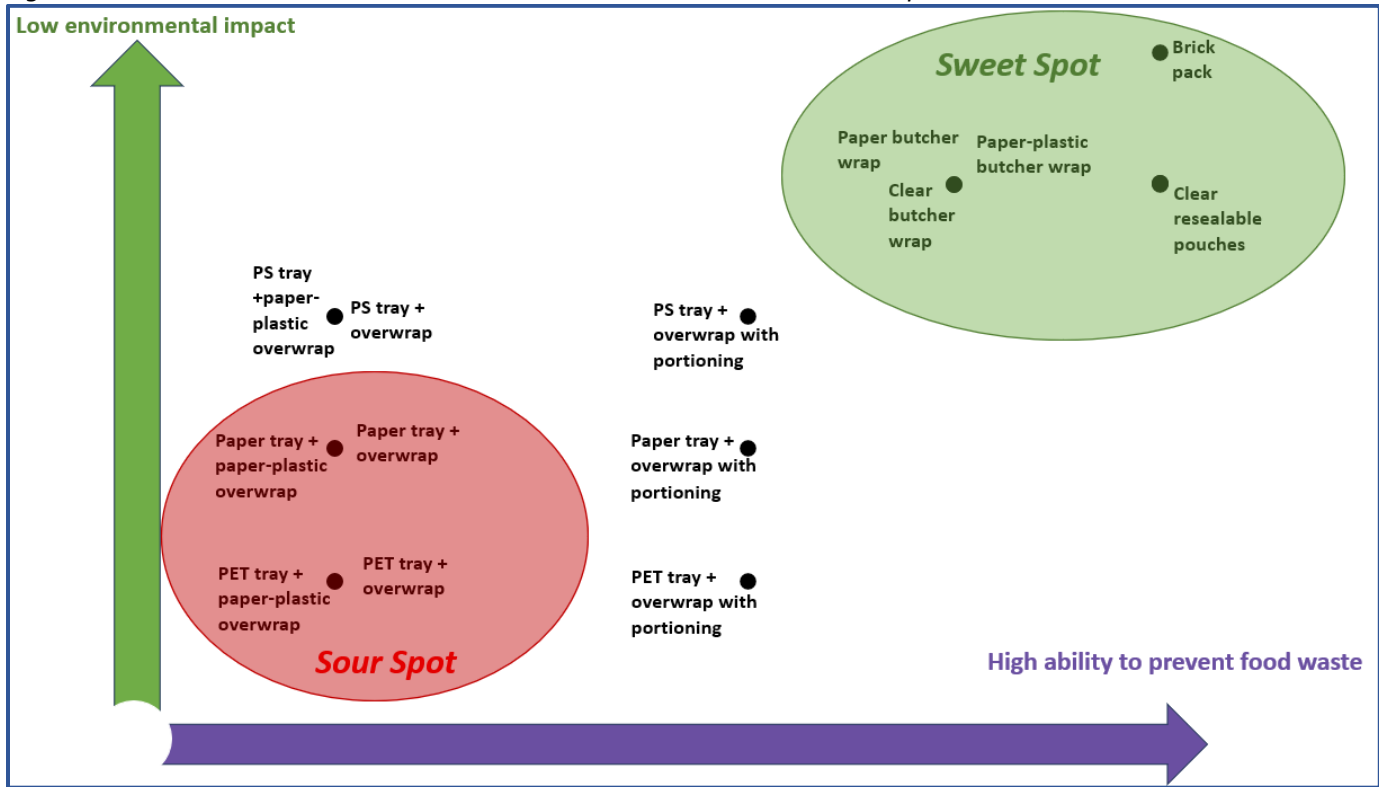
Figure 6.

Clear resealable pouch + paper backing	Butcher paper wrap	PS tray + overwrap	PS tray + overwrap with portioning	PS tray + paper-plastic overwrap
				

Interaction Between Food Waste and Environmental Impact

Similar to the interaction between environmental impact and consumer perception, the "Sweet Spot" category that had the lowest environmental impact and the best impact on preventing food waste is the pouch format. This is the preferred packaging to use if the intent is to connect with consumers on food waste prevention. Pouches that were vacuum packed, resealable and/or had divided portions scored highest within the pouch format.

Figure 7. Interaction between Food Waste Prevention and Environmental Impact



Pouches that were vacuum packed, resealable and/or had divided portioned scored highest within the pouch format. As noted above, the lower environmental impact of pouches within the “Sweet Spot” also represent lower cost packaging that those in the higher environmental impact category. Selected Packages in the pouch format are shown below.

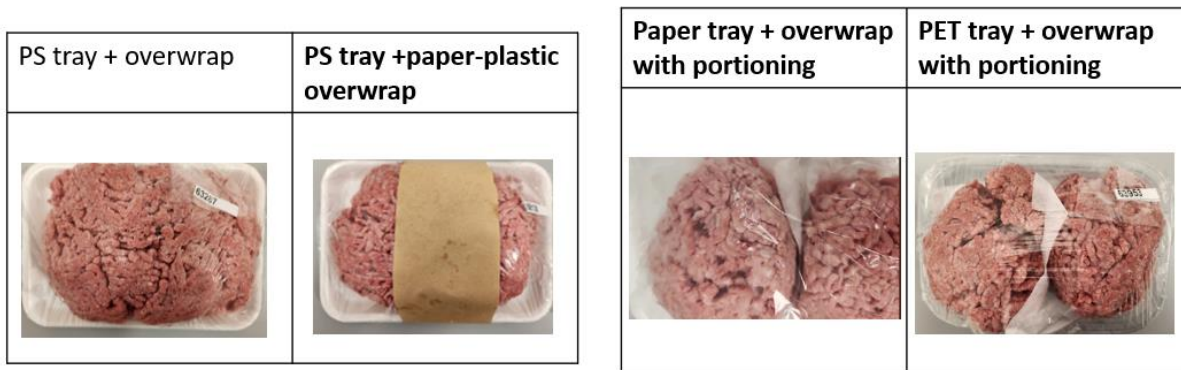
Figure 8.

Brick pack	Clear resealable pouch with portioning	Clear resealable pouch	Clear butcher wrap
			

Similar again to the interaction on environmental impact and consumer perception, the “Sour Spot” category had the highest environmental impact and the lowest impact on preventing food waste was the PET tray and paper wrapping. This is packaging to avoid if the intent is to connect with consumers on food waste prevention.

Packaging that has either the lowest or highest environmental impact but the lowest or highest impact on preventing food waste misaligned in terms of sustainability and food waste. Consumers are most likely to be confused by the environmental claims since the perception is different from the reality. Packages in this category are shown below,

Figure 9.



Actionable RoadMap and Recommendations

An actionable RoadMap and recommendations were constructed from the results. For clarity, this is divided into Food Waste Prevention and More Sustainable Packaging. There are multiple actions that can be taken to improve on food waste prevention and adopt more sustainable packaging.

Food Waste Prevention

- 1a. Implement intelligent packaging at retail locations and food pantries.
- 1b. Implement intelligent packaging at food pantries for NGOs and clients to reduce food waste.
 1. Food Justice Intelligent packaging is an opportunity to provide food safety information and reduce ground beef waste to consumers lacking consistent freezer or refrigeration.
 - Augment more legible and understood date codes with intelligent packaging.
 - Link intelligent packaging on meat to cost savings for consumers who wish to save money by purchasing meat with a shorter shelf life.
 - Align with food pantries to use indicators already at “X days remaining to eat or freeze” to enable planning and meet client nutritional needs.
2. Connect with consumers on food waste with resealable and portioned packaging options.
 - Consumers preferred packaging that inherently allows them to save (freeze) meat for later without transferring it to another container.
 - Employ resealable packaging reduces package size, such as in pouch formats.
3. Connect with consumers who prefer vacuum packaging for beef to food waste prevention.
 - Vacuum-sealed packaging was perceived to protect meat better than other packaging.
 - Convert to packaging that provides direct beef contact with minimal headspace.
 - Increase the number of portions on packaging in brick packs from 2 to 3 to allow consumers to portion more easily.
 - Explore the viability of vacuum packaging of meat on-site in stores.

More Sustainable Packaging

1. Build on the connection of packaging clarity to quality and sustainability.
 - Meat, due to variable quality and being more perishable results in consumers wanting to actually see products versus processed food products, such as cereals, where quality is less of a concern.
2. Connect with consumers on recyclable packaging.
 - Ensure more sustainable packaging is curbside recyclable.
 - Educate about the recycling opportunity of flexible packaging.
 - Expand store drop off (SDO) as a means to connect with consumers who do not have recycling readily available.
 - Link with initiatives that are exploring the feasibility of adopting recycling programs for recyclable PS trays and flexible packaging.
 - Clearly define packaging compostability so consumers understand when industrial composting is required.

Recommended Future Research

The RoadMap and recommendations were used to define further research. For clarity, this is divided into Food Waste Prevention and More Sustainable Packaging.

Food Waste Prevention - Intelligent Packaging

1. Explore funding sources for intelligent packaging.
 - Gauge the opportunity to link intelligent packaging projects for ground beef with funding opportunities in the food waste prevention space.
2. Define how to maximize sales impact and balance the cost-benefit of intelligent packaging for retail beef.
 - Assess retail meat sales as a function of intelligent packaging and:
 - Date code alignment.
 - Reduced prices on meat as shelf life shortens.
 - Communication and reporting of food waste prevention.
3. Define how to maximize sales impact and balance the cost-benefit of intelligent packaging for food pantry beef.
 - Assess food pantry meat sales and food waste prevention as a function of intelligent packaging to
 - Ensure food safety for disadvantaged populations.

Food Waste Prevention - Conversion from Trays to Vacuum Packaged Pouches

4. Define capital support needed to pursue “Sweet Spot” packaging options at beef processors.
 - Define the cost-benefit of capital and equipment funds for beef manufacturing process changes needed to replace trays with vacuum packaging pouch formats that reduce package material and prevent food waste.
5. Define capital support needed to pursue “Sweet Spot” and replace trays with pouches at retail.
 - Define the cost-benefit of capital and equipment funds for retailer butcher processing changes needed to replace trays with lower cost vacuum packaging pouch formats that reduce package material and prevent food waste.
 - Identify equipment and explore value chain alignment needed to use in-store, on-demand meat packaging dispensers that allow consumers to select the quantity of the type of increments from beef in vacuum packaging.

Food Waste Prevention- Conversion to Resealable and Portioned Packaging

6. Define capital and equipment funds needed to convert to resealable packaging at beef processors.
 - Identify resealable packaging technology options.
 - Define capital support manufacturing process changes needed to convert to resealable packaging.
7. Define capital and equipment funds needed to convert to portion control packaging at beef processors.
 - Identify portioning packaging technology options.
 - Define capital and equipment funds and manufacturing process changes needed to convert to portioned packaging, which accommodates a reduced packaging size as beef is used.

More Sustainable Packaging - Recyclable and Recycled Content

8. Identify funding sources to advance recycling opportunities for ground beef packaging.
 - Create unified messaging in the beef industry around sustainable packaging to increase recycling opportunities of ground beef packaging.
 - Develop clear communication on the sustainability of recycling ground beef packaging.
 - Create unified labeling in compliance with legislation to provide clear direction on the recycling of
 - PS trays at recycling centers.
 - Flexible packaging at SDO retail centers.
9. Identify and engage with flexible film packaging recycles on ground beef film potential.

- Explore if extended producer responsibility (EPR) recycling legislation would be a valuable step to incorporate flexible film packaging from ground beef products.
 - Identify alignment and communication needed for SDO retailer compliance.
10. Develop a communication strategy around the use of recycled content in beef packaging.
- Define unified messaging in the beef industry on sustainable packaging to increase recycled content in beef packaging.

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References

- Beef Industry Sustainability Lifecycle Assessment, 2015, <https://www.beefresearch.org/CMDocs/BeefResearch/Sustainability%20White%20Papers%20and%20Infographics/BeefSustainabilityInfographic.pdf>
- Capper, 2011. J. Animal Sci. 89:4249-4261
- Boz, Z., Sand, C., Korhonen, V., 2020. [Consumer Research on Packaging Sustainability-Summary and Research Direction](#). Sustainability
- Boz, Z. and Sand, C., 2020. [The combined effects of nutrient loss and food waste for tomatoes, spinach, and kidney beans as a function of processing conditions](#). Journal of Food Process Engineering.
- Gooch, M. and Sand, C., 2021. [Unwrapping the Arguments ...Solving packaging and food waste through government/industry collaboration](#) VCM International, May
- Oloyede OO, Lignou S. Sustainable Paper-Based Packaging: A Consumer’s Perspective. *Foods*. 2021; 10(5):1035. <https://doi.org/10.3390/foods10051035>
- Schumann, B., and Schmid, M, 2018. Packaging concepts for fresh and processed meat – Recent progresses, Innovative Food Science & Emerging Technologies, Volume 47, <https://doi.org/10.1016/j.ifset.2018.02.005>
- Sand, C., 2023. [A Bright Future for Bioderived Plastic](#). Food Technology, October
- Sand, C., 2023. [Less Packaging, More Sustainability](#), Food Safety Magazine, March
- Sand, C., 2022. [Less Trash Talk: Recycling More Film and Paperboard Packaging](#). Food Technology, July
- Sand, C., 2021. [Sustainability’s 4th Wave](#). Food Technology, December
- Sand, C., 2021. [Rethinking Barrier Films, Food Waste and the Circular Economy](#) Flexible Packaging, October
- Sand, C., 2021. [Meat Packaging Design Capture Consumers’ Attention](#). Food Technology, July
- Sand, C.K., 2019. Quantifying the impact of packaging solutions to reduce food waste in Symposia entitled Packaging solutions to reduce food waste: Packaging Case studies. IFT Annual meeting June 2019
- Sand, C., and Robertson, G., 2018. Packaging Waste Reduction. *Food Technology*, February
- Weinheimer, B., 2019. Beef sustainability: It’s not a buzzword anymore. *Beef Magazine*. June. <https://www.beefmagazine.com/sustainability/beef-sustainability-it-s-not-buzzword-anymore>

Appendix A

Phase 1 Final Report

Appendix B

Focus Group Talk Track