

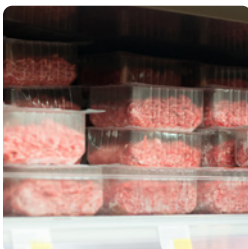
CASE STUDY

FALL 2025



Whole Chain: Ground Beef

Identifying Food Waste Hotspots in the Ground Beef Supply Chain



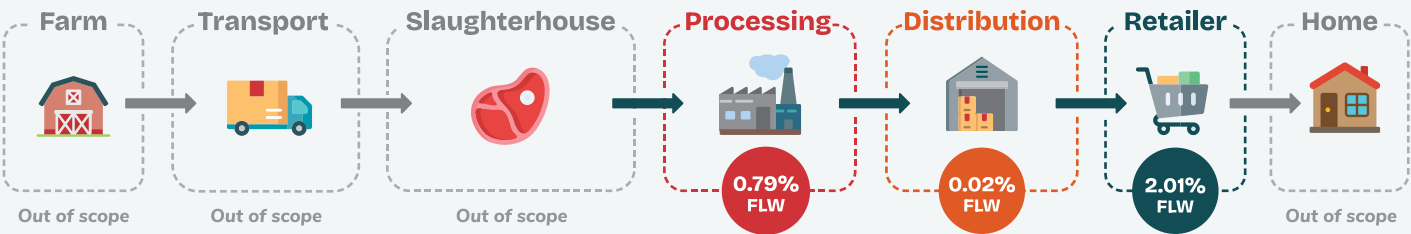
An initiative of



Executive Summary

The U.S. Food Waste Pact commissioned a study on food waste in the ground beef supply chain. Several companies participated in the research, including one processor, two distribution centers, and four retailers. The farm and consumer stages were outside the scope of the study. This initial study explored where and why loss is occurring, with the ultimate goal being to catalyze collaboration among supply chain partners to explore solutions that address the root causes of ground beef loss.

Loss and Impact Applied to all Ground Beef U.S. Market



Causes of Food Loss and Potential Solutions

Food Loss Cause		Potential Solution
Processing Facility	45% of processor losses were caused by ground beef falling to the floor.	Improve the use of conveyor belt guards, optimize conveyor spacing, and install catch trays or reintegration bins.
	31% of processor losses resulted from excess ground beef accumulating at foreign material detectors.	Implement a process to retest and reintegrate the product into the processing line.
	24% of processor losses occurred due to ground beef remaining in machinery between batches.	Develop procedures to collect and reincorporate residual meat from equipment.
Distribution Center (DC) and Retail	60% of DC/retail losses were due to product expiration.	Improve inventory management, and educate employees and consumers on date labels and storage techniques.
	28% of DC/retail losses were due to the aggregate category of poor quality and packaging damages.	Transition to more vacuum packaging and away from ground beef sold in air-permeable overwrapped trays.

Project Overview

Why Ground Beef?

Signatories of the U.S. Food Waste Pact work together to reduce food waste in their operations and across the supply chain. Using a whole-chain approach provides comprehensive insight into the flow of product, relative waste hotspots at each node, and opportunities for waste prevention or redirection. Ground beef was identified as a high interest commodity among retailers due to its high perishability, cost, and environmental impact.

Extrapolating the losses found in this study to the entire U.S. ground beef market shows a clear opportunity for processors and retailers to work together to recapture lost profits and product.

Table 1: Annual estimated losses found extrapolated to entire U.S. ground beef market

USD*
\$644 million
Equivalent to over 2x the cost of NASA's four lunar rovers used in the Apollo missions, adjusted for inflation to 2025
Pounds
77 million
Equivalent to the weight of over 920 Boeing-747 airplanes
Meals
120 million
Equivalent to enough for one meal for every person in California, Texas, Florida, and New York state combined
Acres of Agriculture
367,000
Equivalent to around 25x the size of the island of Manhattan

*Includes retail donation losses. Donations are excluded from the other categories of metrics.

Approach

This case study investigates opportunities to reduce food loss¹ across the supply chain from processing (starting from beef trim inputs at grind processing) to distribution to retail. Though data was not collected at the consumer level, solutions were considered with the potential to influence household waste.

Enviro-Stewards, a B-corporation that measures sustainability impacts and actively supports process improvements for businesses across the supply chain, served as the project research lead. They visited a sample of facilities across the ground beef supply chain, and collected and assessed annual waste data.

Observations, measurements, and interviews were conducted at each facility, and data was analyzed to determine loss rates, top waste causes, and potential solutions to explore for each stage of the supply chain. The proposed solutions were evaluated based on their estimated potential to address key waste hotspots and on businesses' reported feasibility.

Best Practice: GB95

By using low temperature rendering and mechanical separators, lean ground beef (95% protein, 5% fat) can be produced from fatty trim (50% fat or more) without the use of any chemicals. This protein can be used in products such as pizza crumble or added to ground beef batches to increase the lean point. This practice keeps protein in the food supply that may otherwise have been lost.

Findings & Insights

Processor

An average of 45% of the total loss at the processing stage was found to be meat that had fallen to the floor, after which it is considered to be inedible. This happens in various locations, including when meat is dumped into the system at the beginning of the grinding process, between conveyor belts, and at various equipment transfer points. Often this is due to either a lack of or insufficient guarding around hoppers, conveyors being misaligned or too far apart, and inevitable losses at transfer points. Adding or improving guarding, ensuring conveyors are aligned properly, and using catch trays/bins to collect falling meat in a food safe manner so that it can be reintegrated are all potential solutions that can help reduce losses associated with this issue.

Foreign material prevention is an essential part of ground beef processing to remove bits of metal and other foreign materials that cattle may accumulate during growth. However, processors can take measures to reduce the amount of good beef discarded along with any detected foreign material. Re-passing rejected batches of beef in

0.79%

The average loss found at the ground beef processing stage

small increments and accepting portions which successfully pass the foreign material detector three times can isolate the contaminated portion, reducing unnecessary waste. It is essential that the rework of beef be done in a manner to assure product integrity. Additionally, metal detectors must be tested every hour with a sample of product with metal attached to the package; re-using the same test sample throughout a shift is a best practice to reduce waste compared to selecting a new test sample each hour.

Of the total losses found at the processing stage, 24% were due to residual ground beef left in machines and then discarded during equipment cleaning between product runs or at the end of the day.



Table 2
Processor Loss Causes and Potential Solutions

Cause	Meat falling on floor	Foreign material detector	Residual in machines
% Total Waste*	45%	31%	24%
Entire U.S. Market Projected Impacts**	\$32 million	\$22 million	\$17 million
Solutions	Improved guarding Conveyor spacing Catch trays and reintegration bins	Reuse of testing samples Reject re-pass through machines	Scraping out and reintegration of residual beef in blenders Staggered shutdown

*Percent loss of the processor total loss (0.79%).
**Numbers based on total nationwide ground beef sales per the 2024 Power of Meat Report accessed through [MeatPoultry.com](#).

When a facility has multiple product lines running in parallel, conducting a staggered shutdown at the end of the day can save ground beef by transferring the residual ground beef from the equipment in one line into the next line. This requires the ability to run the same product on multiple lines at the end of the day. This practice is in place in one facility that participated in the study.

By design, ground beef blender paddles don't reach the very edge of the blender for the sake of product texture, but this leaves residual ground beef behind during a product changeover (Fig. 1).

✓ Best Practice: Solution

One facility visited in the study shuts down and safely locks out machines after each batch, then uses a long lightweight paddle (Fig. 2) to scrape residual ground beef out of the blenders and incorporate it into the next stage of processing.



Figure 1: Residual ground beef in a blender.



Figure 2: A long lightweight paddle used to scrape residual ground beef out of the blenders in between batches.

Distribution Center and Retail

The primary causes of product loss were the same at distribution centers and retail locations: products expiring (passing the date code marked on the package), poor product quality, and packaging damages. Poor quality and packaging damages were aggregated into one category, due to data limitations on the causes of loss and sometimes a lack of clear distinguishing between the two by the pilot’s retail partners.

Data from DCs was available as overall losses by product for the whole facility, with insufficient data available to determine the ratio of waste by root cause. However, interviews with DC managers consistently revealed expiration and spoilage to be the two main causes for nearly all ground beef waste, with expiration accounting for the majority of loss.

Donated edible products do not constitute food waste, but do represent a financial loss for retailers.

Expiration loss can be reduced with improved inventory management software with more automation, especially date tracking and lost pallet prevention. Though these tools require upfront investment, they represent longterm savings opportunities.

0.02%

Average loss of ground beef at the distribution stage

2.01%

Average loss of ground beef at the retail stage with an additional 1.72% of ground beef donated



Figure 3: Ground beef discarded in the back of a retail store due to poor quality and packaging damage.

Packaging damage and associated loss can be reduced by a transition to vacuum packaging and away from overwrapped trays and motherbags, both of which are commonly damaged during handling, leading to discarded ground beef (Fig. 3). A switch to vacuum packaging could also reduce the number of losses associated with expiration, due to the product’s longer shelf life.



Table 3
Distribution Center & Retail Loss Causes and Potential Solutions

Cause	Expired product	Poor quality and package damages
% Total Waste*	60% of losses	28% of losses
	69% of donations	27% of donations
U.S. Market Projected Impacts	\$395 million	\$99 million**
Solutions	- Improved inventory management software - Consumer education	Vacuum packaging

*Losses represented as percent of the retailer total loss (2.01%) and donations represented as percent of retailer total donations (1.72%). The ratio of waste by root cause at DCs was not able to be determined due to insufficient data.
**Potential vacuum packaging savings are scaled down to 58% of the ground beef market, because 58% of U.S. ground beef is sold in overwrap or Modified Atmosphere Packaging (MAP)—which are those packaging types found to be most prone to damage/puncturing at the stores surveyed and that would benefit the most by being replaced by vacuum packaging, which was less prone to damage at the stores and DCs.

Whole Chain Solutions to Ground Beef Loss

Two of the major sources of loss, product quality and packaging damages, could be addressed by a transition away from tray and overwrap towards vacuum packaging. Packaging occurs at the processor, but is dictated by consumer demand at the retail stage, making this an opportunity for whole chain collaboration.

There are four ways ground beef is packaged for retail stores:

88%

of ground beef losses at the DC/Retail stages were due to expired product, poor quality, and packaging damages

representing a loss of 55 million lbs, 81 million meals, 36,000 acres of land, and \$308 million dollars when extrapolated to total U.S. Ground Beef Market.

1. Tray and air-permeable overwrap ground beef packaging (Fig. 4).

Overwrap packaging requires secondary packaging called a motherbag—a plastic barrier bag filled with a modified atmosphere and oxygen scavenger inside to delay oxidation and prevent spoilage during shipping and storage.



Figure 4

2. Modified atmosphere packaging (MAP) of ground beef (Fig. 5).

Typically consisting of a rigid tray and sealed plastic cover, MAP includes a precise mix of gases to extend shelf life, sometimes with the addition of carbon monoxide to turn the beef a bright red color (see Fig. 8 for myoglobin redox states and corresponding color changes).



Figure 5

3. Chub packaging of ground beef (Fig. 6).

This is close to vacuum packaging, but a perfect vacuum is never actually induced—most of the air is just forced out by ground beef filling the package. The seals on the ends are typically not perfect, allowing some air to contact the ground beef.



Figure 6

4. Vacuum-packed “brick-pack” ground beef (Fig. 7).

Vacuum-packed ground beef offers the longest shelf life and is the packaging option least likely to be damaged during transport. The purple-red color is due to the lack of O₂ or CO leaving myoglobin in a reduced state (see Fig. 8 for details).



Figure 7

SHORTEST SHELF LIFE**LONGEST SHELF LIFE****Tray and air-permeable overwrap ground beef packaging****Modified atmosphere packaging (MAP) of ground beef****Chub packaging of ground beef****Vacuum-packed “brick-pack” ground beef****MOST OXYGEN EXPOSURE****LEAST OXYGEN EXPOSURE**

Figure 8

In terms of shelf life, vacuum-packed ground beef lasts the longest, followed by chubs, then modified atmosphere packaging (MAP), with overwrap packaging offering the shortest shelf life.²

Despite its inferior shelf life, consumers are known to prefer the cherry-red color of over-wrapped ground beef over the purple-red color of vacuum-packed beef, believing the cherry-red color to be a sign of freshness.³ The color of beef is determined by the redox state of the protein myoglobin. Oxygen reacts with myoglobin to turn beef bright red, but contact with oxygen also leads to degradation and spoilage. Modified Atmosphere Packaging (MAP) adds and removes certain gases in the package to extend shelf life while turning the beef a red color to meet consumer expectations. However, it is still outperformed in shelf life by fully vacuum sealed “brick” packaging.⁴

Observationally, retailers and donation partners indicated in interviews that vacuum packaging is less easily damaged than overwrap packaging, and is easier to stack and freeze. For this structural reason, vacuum packaging may reduce food loss along the supply chain while also helping to prevent leakage and contamination with other products.

Finally, though full cost analyses were not part of this study, vacuum packaging is likely less expensive to manufacture, package, and ship than overwrap or MAP forms. Overwrap requires a machine each for stuffing, wrapping, labeling, and sealing trays inside the motherbag. The additional materials of inert gases, an absorbent pad on the tray under the ground beef, and an oxygen scavenger packet contribute extra cost and complexity to the process. The large volume occupied by a motherbag drastically increases the cost of shipping and has a negative impact on shipping sustainability.

In summary, vacuum and chub packaging results in less material expense, more efficient and less expensive shipping, and less packaging waste going to landfill than the alternatives. The major challenge with transitioning to predominantly vacuum-packed options of ground beef is a consumer perception linking cherry-red-colored beef to freshness and quality.

Educating consumers that the color difference between cherry-red and purple-red ground beef is due to packaging atmosphere—not freshness—could help shift preferences.

Conclusion & Next Steps

When scoping a pilot to introduce more vacuum-packed ground beef to the supply chain, the following potential benefits and challenges should be assessed:

Potential Benefits	Potential Challenges
Greater supply chain flexibility due to the longer product shelf life.	Consumer perceptions of ground beef color and associated freshness, and potential for altering through consumer education campaigns.
Reduced packaging, manufacturing, and transportation costs.	
Increased sales of ground beef due to longer shelf life and reduced packaging damages.	An in-depth analysis of the payoff needs to be conducted to understand the business case for switching production lines to a different form of packaging, as making these changes can initially be time intensive and costly.
Increased customer satisfaction and perception of quality, leading to increased purchasing of ground beef.	
Reduction in amount of plastic packaging and lower environmental footprint.	

This study explored key hotspots of waste in the ground beef supply chain. As a second phase of this project, the U.S. Food Waste Pact will continue to explore the potential solutions identified in the case study, particularly the solution to switch to more vacuum-packaged beef, which was identified by business pilot participants as a high potential option.



Endnotes

- 1 Loss was defined as food which can no longer be destined for human consumption, and was calculated using a mass balance approach (the difference between inputs and outputs at each stage).
- 2 McMillan, K. W. (2008). "Where is MAP Going? A review and future potential of modified atmosphere packaging for meat." *Meat Science*, 80(1), 43–65: <https://doi.org/10.1016/j.meatsci.2008.05.028>
- 3 Thies, A. K., M. Holloway, B. A. Altmann, A. M. Countryman, C. Smith, M. N. Nair (2025). "Addressing retail meat waste: A focus group study on discolored beef." *Food and Humanity*, 4, 100639: <https://doi.org/10.1016/j.foohum.2025.100639>
- 4 Rogers, H. B., J. C. Brooks, J. N. Martin, A. Tittor, M. F. Miller, M. M. Brashears (2014). "The impact of packaging system and temperature abuse on the shelf life characteristics of ground beef." *Meat Science*, 97(1), 1–10: <https://doi.org/10.1016/j.meatsci.2013.11.020>

Acknowledgments

The U.S. Food Waste Pact team would like to thank Enviro-Stewards for their leadership and authoring of this case study. The Pact would also like to thank the participating processors, distributors, and retailers for their collaboration on this effort. If you would like to know more about the methodology for this project, please request this case study's technical appendix by emailing Nia D'Emilio at nia.demilio@refed.org.

To learn more about the U.S. Food Waste Pact, please email Kristen Lee at kristen.lee@refed.org.

About Enviro-Stewards

Enviro-Stewards is an engineering consulting firm whose mission is to cultivate resilient businesses and improve lives in extraordinary ways. They are committed to assisting corporations to significantly reduce their environmental impact, with a focus on comprehensive decarbonization strategies. They are a Best for the World classified B Corporation and the only Canadian company to win a Global SDG award. They help manufacturing facilities to reduce food loss & waste as well as conserving water and energy.



About the U.S. Food Waste Pact

The U.S. Food Waste Pact is a national voluntary agreement to help food businesses accelerate progress toward their waste reduction targets. Led by national nonprofit partners ReFED and World Wildlife Fund, the U.S. Food Waste Pact is aligned around the global framework of "Target, Measure, Act" to help food businesses reduce waste within their operations.



Partner Leads



U.S. Food Waste Pact Commitment Business Signatories

(As of Fall 2025)

Retail



Foodservice



Quick-service Restaurants



Hospitality



Manufacturing



Distribution



Trade Associations

