Sustainability

Executive Summary


IX
Y696

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Introduction

Beef Industry Sustainability: Meeting growing global demand by balancing environmental responsibility, economic opportunity and social diligence throughout the supply chain.

A Journey of Continuous Improvement

Ensuring a sustainable food supply is undoubtedly one of the greatest societal challenges. By 2050, 70 percent more food will be required to feed the growing population and all agricultural production will be needed to meet the increasing demand.

Today, a sustainable food supply includes balancing efficient agricultural production with environmental, social and economic attributes. The beef community recognizes the important role it plays in contributing to more sustainable food and has committed to a journey toward more responsible beef production. As a first step, the Beef Checkoff Program launched a comprehensive assessment to quantify and benchmark environmental, social and economic aspects of beef industry sustainability.

This beef industry life cycle assessment is not intended to compare one beef production practice to another. Instead, it is designed to provide a benchmark which will help all beef operators along the supply chain find individual means of improving the efficiency and sustainability of their operations.

The beef industry is the first food system to benchmark its current status in a holistic manner that encompasses all three aspects of sustainability. The research included an evaluation of thousands of data points to quantify the industry's progress since 2005. By documenting that progress, the beef community can for the first time provide science-based answers to questions about its sustainability.

Approach

Beef production involves more complex biological processes than any other food system. The completion of this life cycle assessment required the entire value chain to work together to account for inputs and outputs. That cooperation between segments marks a new chapter for the beef community and demonstrates the industry's commitment to a path of continuous improvement.

Conducting a Sustainability Assessment

Defining sustainability is challenging because it means different things to different stakeholders. In an effort to determine the most relevant of these attitudes about the sustainability of beef, the research team and contractor BASF Corporation conducted a perception analysis, which gathered opinions about beef production practices from a wide swath of stakeholders and thought-leaders.

The compilation of these perceptions (Figure 1) allows beef producers to focus their improvement efforts in areas with the greatest perceived importance. For example, because animal welfare was ranked as highly important by stakeholders, the industry can focus on making progress toward improved sustainability by focusing its efforts on initiatives such as Beef Quality Assurance.

A sustainability assessment requires the use of life cycle assessment methodology to measure the impacts of production. A life cycle assessment is essentially an accounting system that uses complex models to quantify all inputs and outputs involved in producing beef, from birth of the animal to the consumer's plate (Figure 2). Inputs along the entire value chain were included, from the pre-chain production of fertilizer, packaging, chemicals and others; to primary inputs like feed and water, through consumption and disposal of packaging materials by the consumer. These impacts were quantified against a consumer benefit (CB) of one pound of boneless, edible, consumed beef.

The Beef Industry Sustainability Assessment was designed to capture how industry changes and improved management practices have affected beef's long-term sustainability. Significant changes in industry practices led to the selection of benchmark years. The 1970s were chosen because they reflect the shift to the production of boxed beef. The benchmark year of 2005 was selected to reflect the widespread use of distillers grains in feedlots. The final benchmark year, 2011, represents the present day beef value chain.

Figure 1 | Perception Analysis

Figure 1: Stakeholders were asked to define beef sustainability. This Figure represents the most common definitions given by stakeholders. The beef industry definition of sustainability, "balancing environmental responsibility, economic opportunity and social diligence," encompasses stakeholder perceptions.

Approach

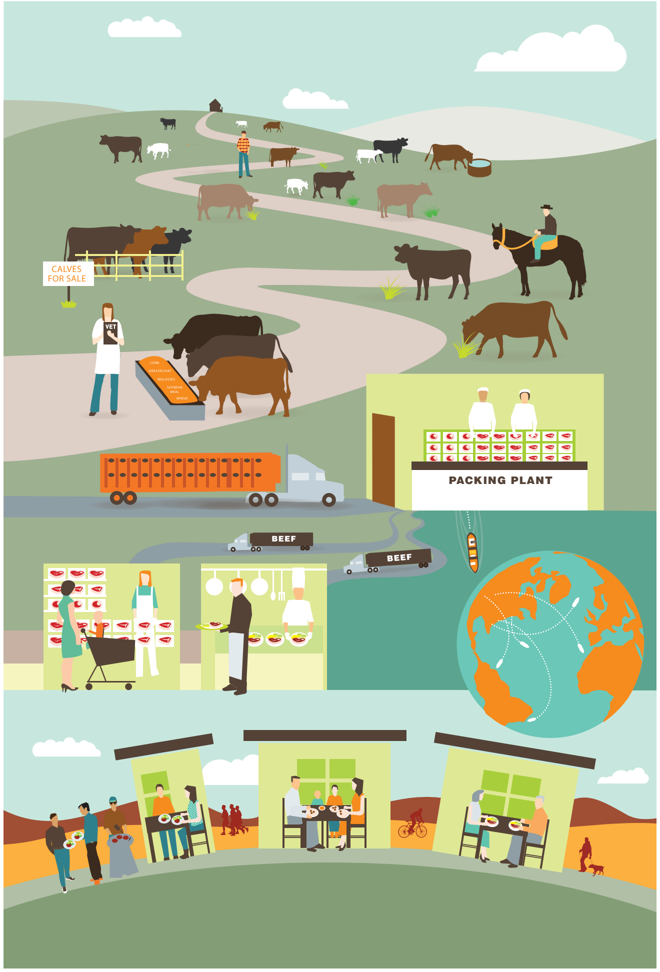


Figure 2 | Beef Life Cycle

Beef production is extremely complex and conducting a thorough life cycle assessment required the development of new methods to account for the inputs and outputs of the entire production process. Two independent models were used to quantify the sustainability of the beef value chain. One model was used to simulate biological processes on-farm; the other was used to quantify impacts in the post-harvest sector.

Pre-harvest Data Collection

For Phase 1 of the Beef Industry Sustainability Assessment, the data used to simulate the pre-harvest sector, which includes cow-calf and feedlot segments, were gathered from the United States Department of Agriculture's (USDA) Meat Animal Research Center (MARC) in Clay Center, Nebraska. Utilizing the MARC records, which date back to the 1970s, the research team was able to predict all on-farm processes (for example, crop and animal performance, irrigation, etc.) through use of the Integrated Farm System Model (IFSM).

By combining MARC data with the simulation capacity of the IFSM, the research team gained the benefits of a transparent system, with years of research-proven accuracy to back it up.

The model was used to simulate 25 years of weather and its impact on crop production, feed use and animal performance, as well as the return of nutrients back into the land at the MARC facility. For example, growth and development of crops were predicted for each day of the growing season based on soil, water, nutrient availability, ambient temperature and solar radiation. In the case of cattle predictions, the IFSM model was used to simulate animal growth; lactation requirements for cows; maintenance requirements for cows, calves, replacement heifers and finished cattle; and the nutrient content of any manure produced (Figure 3).

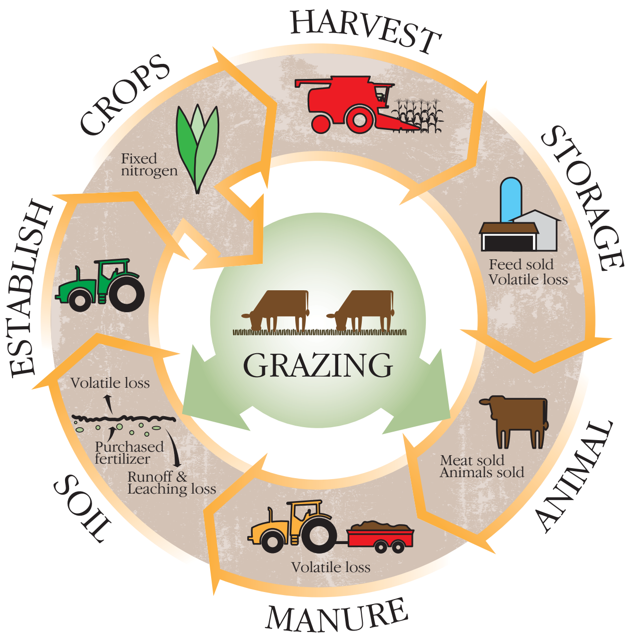


Figure 3 | Pre-harvest: IFSM

Some of the results comparing model accuracy to actual data collected can be seen in Table 1.

Table 1 | Actual reported vs. IFSM-simulated feed production at USDA MARC for 2011

Feed Type	Actual tons Dry Matter	Simulated tons Dry Matter	% Difference
Alfalfa / grass hay silage	6,096	6,102	0.0
Corn silage	5,444	5,422	0.4
High-moisture corn	3,092	3,109	0.5
Corn grain	1,834	1,820	0.8
Distillers grains	1,841	1,837	0.2
Total	**18,307**	**18,290**	**0.0**

Approach

Although the MARC data and IFSM were demonstrated to be highly accurate and representative of beef cattle production systems in the United States, some significant differences exist between MARC production practices and those elsewhere in the country. Therefore, further research is needed to regionalize the data to better represent average production systems in other parts of the country, which will be included in Phase 2 of this project.

Post-harvest Data Collection

The life cycle assessment for post-harvest considered the packing, case-ready, retail and consumer segments of the beef supply chain. The packing and case-ready segments contributed significant resources, including a robust data set, to allow for the completion of the analysis.

For the purpose of conducting Phase 1 of this life cycle analysis, all beef was assumed to be packaged in a case-ready system. Data from the consumer and retail segments were derived from publicly available sources (the U.S. Environmental Protection Agency, USDA, Food Marketing Institute and the U.S. Bureau of Labor Statistics) as no primary data were available from retail sources. As a result, the life cycle assessment showed no improvements from 2005 to 2011 for the consumer and retail segments.

BASF Corporation's life cycle assessment model, the Eco-efficiency Analysis (EEA), provided the framework required to analyze the environmental, social and economic impacts of the post-harvest segments of the beef value chain. The model was then populated with data from the pre-harvest simulations to allow the entire life cycle to be benchmarked. Beef supply chain sustainability was compared over time against the consumer price of beef in accordance with ISO 14040 and 14044 for life cycle assessment and 14045 for eco-efficiency analysis.

It is important to recognize that the science of life cycle assessment requires analyzing all production inputs, including pre-chain impacts, that contribute to producing one pound of boneless, edible, consumed beef. Due to the beef industry's inability to influence changes in pre-chain impacts, gaining efficiencies in this area is a challenging prospect. However, because many of those industries are also on a path of continuous improvement, the beef industry benefits from pre-chain progress. For example, as diesel engines are improved to lower emissions and improve fuel efficiency, the beef industry benefits and shows a decrease in both air emissions and resource use.

Third-party Certification

The completed Beef Industry Sustainability Assessment has been subjected to extensive third-party and peer review. The pre-harvest segment results are published in the *Journal of Animal Science* and The U.S. Beef – Phase 1 Eco-efficiency Analysis, which examined the entire beef value chain, was certified by NSF International in July 2013.

Findings

The EEA portfolio shows the present-day U.S. beef value chain is more sustainable than in 2005 (Figure 4). While there was a 6 percent increase in the price of beef between 2005 and 2011, there was a simultaneous decrease in the overall environmental and social impacts from the U.S. beef value chain of approximately 7 percent. Following weighting and normalization, the EEA portfolio showed a 5 percent improvement in overall sustainability.

All impacts are quantified against a consumer benefit (CB) of one pound of boneless, edible, consumer beef.

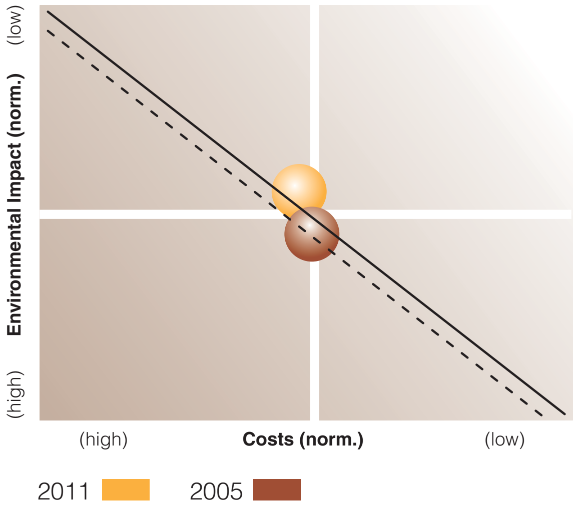


Figure 4 | Eco-efficiency Portfolio: U.S. Beef

Economic Impact Category

The importance of economic benefits to the beef industry cannot be overstated and is a critical component of sustainability. However, measuring the economic benefit of one pound of boneless, edible beef is challenging due to the complexity of the industry. To measure the economic sustainability of the entire beef value chain, the consumer price of beef is utilized. The researchers acknowledge the economic benefit of beef extends beyond just consumer price and further research in this sustainability category is required.

The results of the life cycle cost analysis were adjusted to reflect current market conditions and pricing; therefore, 2005 pricing was adjusted to 2011 dollars. The results of the life cycle cost analysis showed a price increase of 6 percent between 2005 and 2011 (Figure 5).

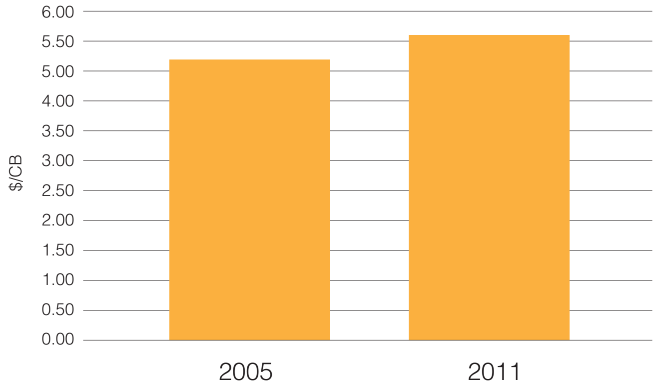


Figure 5 | Life Cycle Costs

Environmental and Social Impact Categories

Improvements in efficiencies have driven the majority of the increases in overall beef value chain sustainability. Because it is difficult to improve biological processes in short time periods, enhancements to pre-chain manufacturing processes, as well as major innovations and investments in infrastructure by the packing and case-ready sectors, contributed heavily to the recent improvements in industry sustainability.

Environmental and social impact categories shown in this fingerprint highlight areas important when measuring sustainability. In this report seven impact categories are highlighted; five are environmental (energy use, consumptive water use, emissions, resource use and land use) and two are social (toxicity potential and occupational illnesses and accidents). Overall, improvements were seen in nearly all impact categories between 2005 and 2011 (Figure 6).

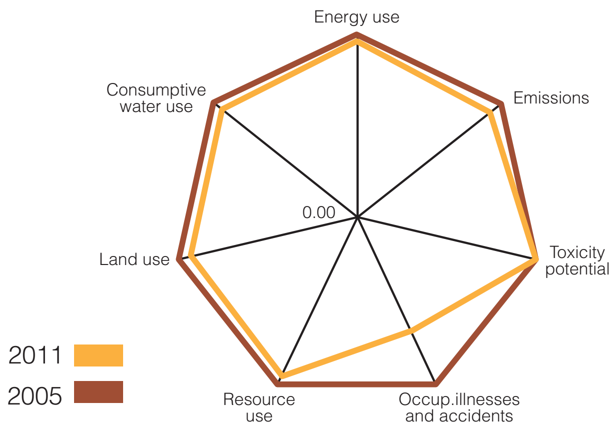


Figure 6 | Environmental Fingerprint

Environmental Impact Categories

Energy Use

The greatest energy impacts for the beef industry are the result of embodied energy requirements dictated as standard practice by life cycle assessment protocols. Embodied energy is how life cycle assessments level the playing field for all energy sources. In order to compare energy sources, the energy source must be calculated by converting it to its most efficient use. In the case of corn, that most efficient use is combustion. Because most of the corn utilized in beef production is utilized as a feed source, the beef industry showed a larger than expected cumulative energy demand. Nearly 80 percent of the industry's cumulative energy demand is the result of embodied bioenergy in the form of animal feed (Figure 7).

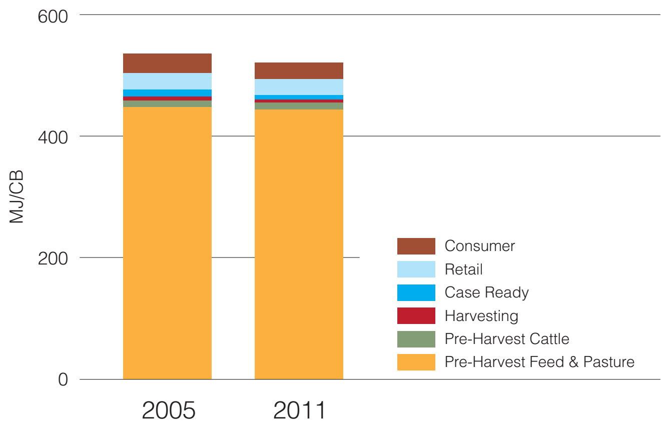


Figure 7 | Cumulative Energy Demand

Since embodied energy from feed sources such as corn is not easily reduced, it is important to recognize that the main opportunities for reduction in this category are found in the non-renewable energy associated with the current U.S. energy grid and transportation system, as seen in Figure 8. Between 2005 and 2011, the beef value chain lowered its energy use by 2 percent (Figure 7 & 8). The reductions in energy use can be attributed to the following factors:

- Reduced use of utilities and transportation energy throughout the value chain
- Increased crop yields and less fuel use to produce required feed resources
- Increased use of biogas capture and conversion by packing plants, leading to lower electricity requirements
- Conversion of boilers at packing plants from diesel to natural gas
- Reduced packaging requirements through the use of right-size packaging which reduced the pre-chain impacts of packaging production

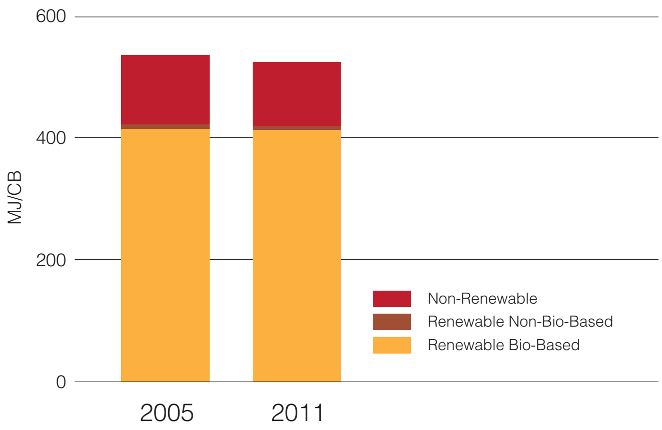


Figure 8 | Renewable and Non-Renewable Energy Breakout

Consumptive Water Use

Crop irrigation accounts for 95 percent of water use by the beef value chain. In this impact category a 3 percent reduction in use was achieved between 2005 and 2011 (Figure 9). Reductions in consumptive water use were the result of several factors, including:

- Improved crop yields and reduced water use to produce required feed resources
- Improvements in packing plant water efficiency
- Optimizations in the case-ready phase that lead to packaging reductions and reduced pre-chain water use

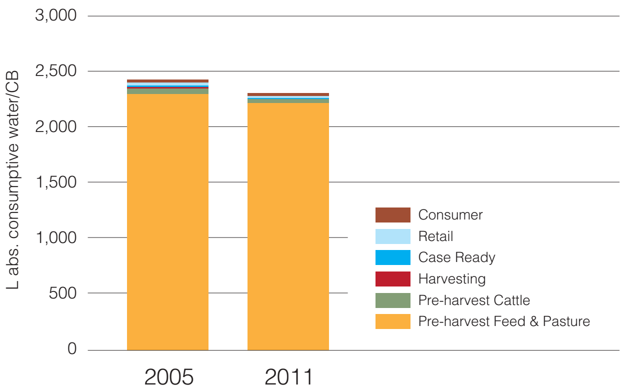


Figure 9 | Consumptive Water Use

Emissions

The emission impact category measures emissions to water, soil and air.

Emissions to Water

The life cycle assessment attributed 78 percent of emissions to water to run-off in 2005 and 81 percent in 2011, largely due to nutrient leaching from cropland. However, the beef value chain has a positive story to tell in this category. In the six years between 2005 and 2011, emissions to water decreased 10 percent (Figure 10) as a result of several improvements in production and management practices, including:

- Increased crop yields which decreased fertilizer use and associated run-off per unit of feed produced
- Installation of gray water recycling equipment in packing plants and increased use of right-size packaging
- Associated reductions in pre-chain emissions and increased usage of wet distillers grains

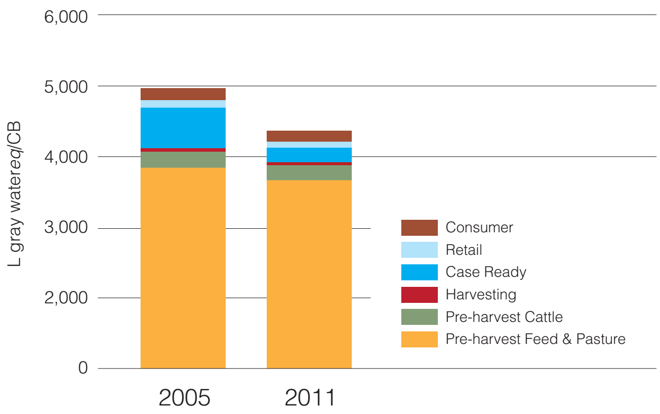


Figure 10 | Emissions to Water

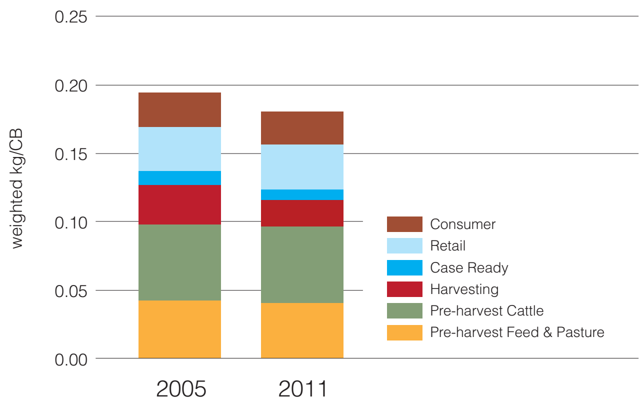


Figure 11 | Solid Waste Generation

Emissions to Soil

Emissions to soil are measured as solid waste generation and analyzed according to ultimate disposal method—recycling, incineration or landfill. Nearly all solid waste accounted for in Figure 11 was the result of pre-chain waste. Solid waste generated by pre-chain production declined 7 percent between 2005 and 2011 (Figure 11) as a result of:

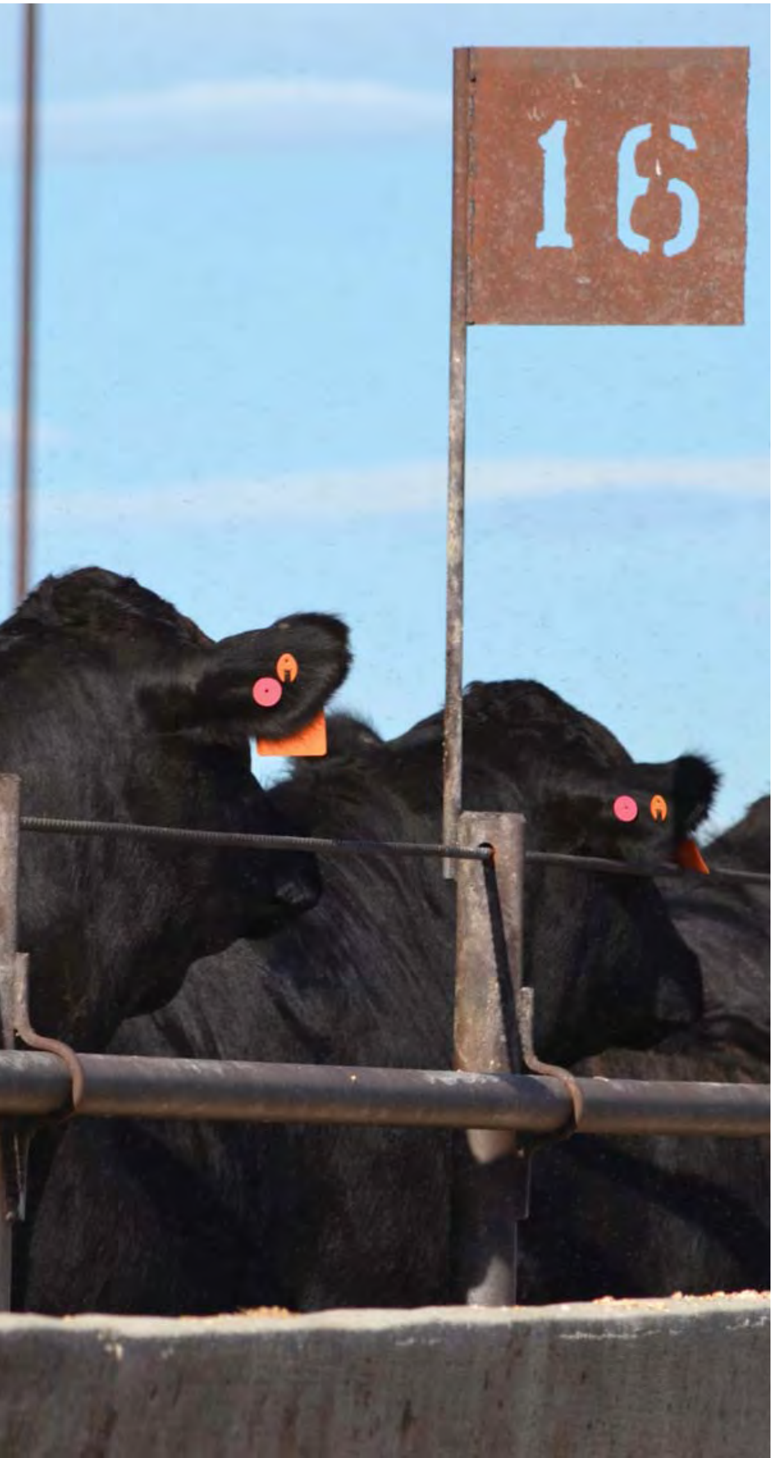
- Greater use of biogas at packing facilities
- Improved crop yields

Emissions to Air

There are four primary sub-categories of air emissions measured by the life cycle assessment. Those sub-categories include greenhouse gases, acidification potential, photochemical ozone creation potential and ozone depletion potential.

Greenhouse Gases

Enteric methane from cattle is the largest contributor to the global warming potential (GWP) of the beef value chain,



accounting for 42 percent of the total. Nitrous oxide (N_2O) from manure in feedlots and pastures was the second-largest source of GWP, accounting for 20 percent of the total. Other significant contributors include field emissions from fertilizer, refrigerant leakage from the retail sector and cooking of beef products by consumers. Some improvements in greenhouse gases achieved over the last six years were canceled out by the increased use of wet distillers grains which have a higher GWP as a result of the pre-chain ethanol distillation process. However, the beef supply chain has still reduced its carbon footprint by 2 percent since 2005 (Figure 12) through:

- Increased use of recovered biogas and right-size packaging which results in less fossil fuel use
- Increased crop yields resulting in less fossil fuel inputs to feed production
- Improved animal performance which maximizes feed-to-gain ratios

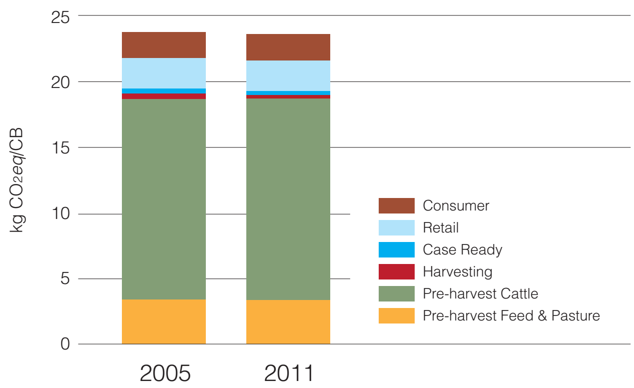


Figure 12 | Greenhouse Gas Emissions

Acidification Potential

The major contributors to acidification potential come from the pre-harvest phases of cattle production. Manure and urine from cattle and the use of fertilizer in feed production are the primary contributors. Emissions from the combustion of fossil fuels for transport, production of electricity, on-site boiler use and pre-chain impacts of corrugated cardboard production also contributed to the beef industry's acidification potential emissions.

The inclusion of wet distillers grains in cattle feed rations increased ammonia emissions, which contributes to acidification potential. However, decreased fertilizer and fossil fuel combustion from feeding distillers grains offset the increased ammonia production. Overall acidification potential was reduced 3 percent since 2005 (Figure 13) from:

- Increased crop yields resulting in more efficient utilization of applied nitrogen from fertilizer or manure
- Increased energy efficiency, use of captured biogas and packaging optimizations which lower pre-chain acidification potential emissions

Photochemical Ozone Creation Potential (POCP)

The main contributors to POCP, also known as summer smog, are volatile organic compounds which are emitted primarily from the use of feed resources such as silage and wet distillers grains, as well as fossil fuel combustion and the pre-chain emissions created by the use of corrugated cardboard and plastic. The results of the life cycle assessment show a slight reduction in POCP emissions in the post-harvest sector between 2005 and 2011 due to the increased use of biogas capture and conversion technology, as well as increased use of right-size packaging. However, those improvements were nearly offset by the increased usage of high-moisture corn and silage by the pre-harvest sector at MARC during the same time period (Figure 14).

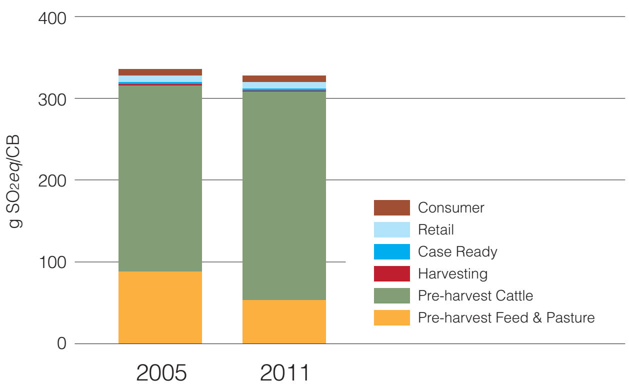


Figure 13 | Acidification Potential

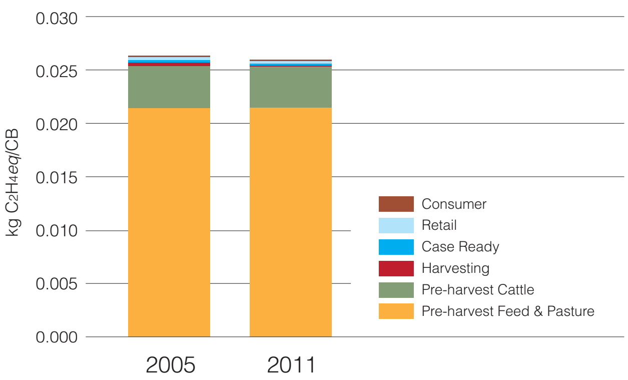


Figure 14 | Photochemical Ozone Creation Potential

Ozone Depletion Potential (ODP)

Halogenated hydrocarbons utilized by commercial refrigeration systems at retail are the most significant contributors to the ODP emissions measured in the life cycle assessment. Because of the lack of primary data submitted by retail and restaurant stakeholders, the only available data were open-source data from the U.S. Environmental Protection Agency. These data are not updated frequently enough to capture improvement during the timeframe of the assessment. Other contributors to ODP include the use of low-density polyethylene (LDPE) packaging (Figure 15).

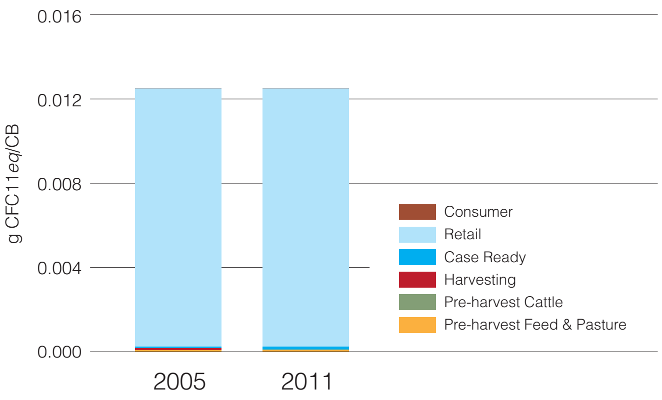


Figure 15 | Ozone Depletion Potential

Resource Use

Resource use impacts are weighted, with more finite resources being assigned a higher weighting than more plentiful resources. Zinc is one of the world's most finite resources. As a result, even though it is used in small quantities by the beef industry, it adds significant burdens to the beef value chain's overall resource use impact, accounting for half of the total. Fossil fuel use also factors heavily into the industry's resource use and can be primarily attributed to pre-chain production processes for transport, processing and feed production. The production-related (the distillation process) impacts of the distillers grains used in cattle rations also contributed slightly to resource use as well.

The beef value chain's resource use has improved by 2 percent during the past six years (Figure 16). Although the reduction may appear small, the beef industry has made significant efficiency improvements. For example, farmers and ranchers are producing more total product per animal. The result is an improvement in industry efficiency and a lowered overall resource use impact. Other improvements in the resource use category were realized as a result of:

- Improved crop production practices and increased crop yields
- Increased use of recovered biogas from wastewater lagoons at packing plants, thereby lowering the need for fossil fuel use

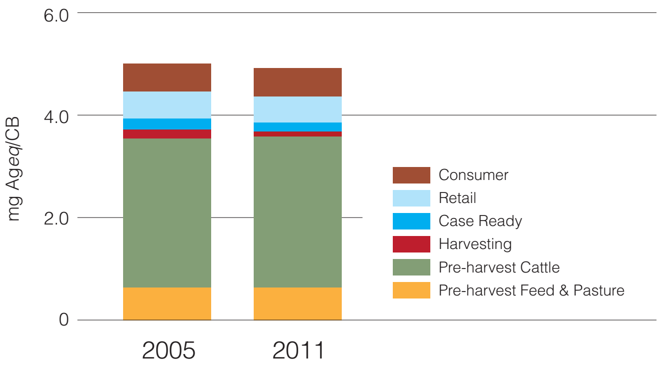


Figure 16 | Resource Use

Land Use

The beef value chain has reduced land use by 4 percent from 2005 to 2011 (Figure 17). The beef industry's use of farm land, pasture and rangeland accounts for the bulk of land use impact, accounting for 95 percent of the category. The majority of the remaining land use is the result of pre-chain processes such as the production of corrugated cardboard and diesel consumption.

Future research on land use was identified as a significant priority for the beef value chain, as grazing ecosystems are complex and not well represented by current life cycle assessment methodology. Overall reductions in land use can be attributed to:

- Increased crop yields, which resulted in a decline in the total number of acres required for feed production
- Use of distillers grains, which reduced the need for additional crop acres used for feed production

- Right-size packaging which lower the industry's use of cardboard and other packaging products
- Improvements in energy efficiency across the entire beef value chain

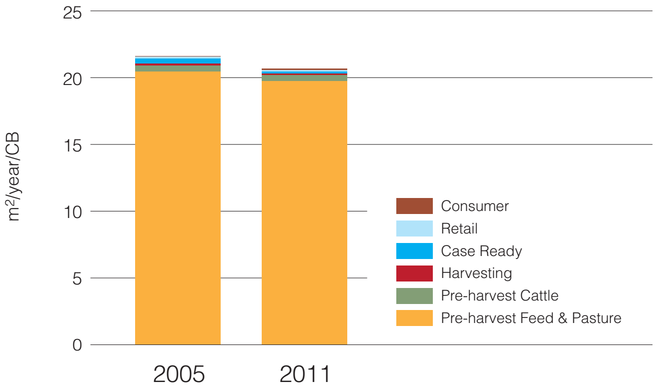


Figure 17 | Land Use

Social Impact Categories

Toxicity Potential

Agricultural chemicals and fertilizers are the primary contributors to toxicity potential because they can pose a human health risk. Fossil fuel energy, pre-chain utilization of chemicals, utilities and transportation also contribute to this category.

In the six years measured in the life cycle assessment, toxicity potential was essentially unchanged (Figure 18). Reductions in toxicity potential were achieved due to the increased use of recovered biogas from lagoons at harvesting facilities, which reduced energy and fossil fuel consumption. A decreased use of plastics in packaging lowered pre-chain toxicity potential. In addition, other energy efficiency improvements throughout the value chain resulted in lower fossil fuel use. However, the increased use of distillers grains increased ammonia releases from urine and effectively neutralized these improvements.

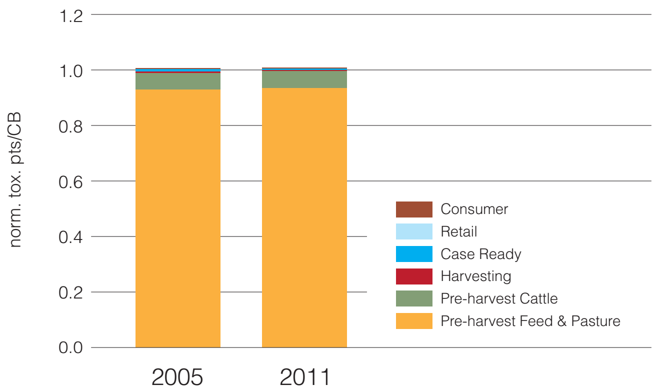


Figure 18 | Toxicity Potential

Occupational Illnesses and Accidents

The single-largest categorical reduction came in occupational illnesses and accidents, which declined 32 percent in the six years between 2005 and 2011 (Figure 19). The data was compiled from the U.S. Bureau of Labor Statistics and showed improvements in the numbers of working accidents, fatalities, illnesses and diseases associated with industries related to the production of beef. Other categories in this social metric include animal welfare, food safety and community nuisance odors and emissions. Significant improvements in these areas resulted from:

- A decline in the numbers of pre-chain and packing sector occupational accidents, illnesses, injuries and diseases
- Improvements in animal welfare, as reflected in a third-party audit result of packing plants and adoption of Beef Quality Assurance at the feedyard and cow-calf sectors
- The installation of covered lagoons, which lowered community nuisance odors and reduced packing plant dependence on fossil fuels (which reduced pre-chain occupational accidents and illnesses)

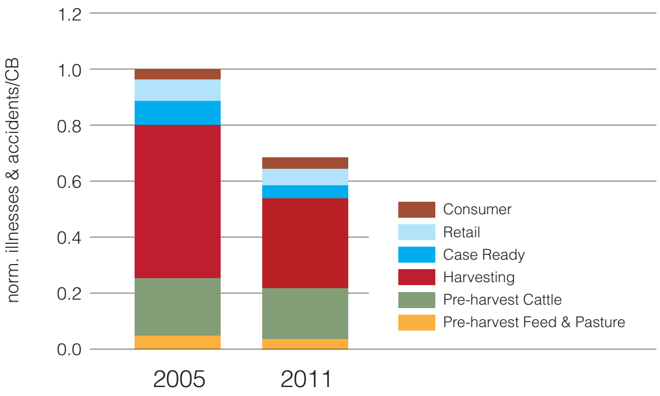


Figure 19 | Occupational Illnesses and Accidents

1970s Pre-harvest Data

Initially, the intent of this project was to benchmark the 1970s, which represented a time in the industry of increased carcass utilization and fabrication, known as the "shift to boxed beef." While high-quality data for the pre-harvest sector is available dating back to the 1970s, data is not available from the post-harvest segment. Therefore, the following benchmark data focuses solely on the pre-harvest sector between 1970, 2005 and 2011. Since the 1970s, efficiencies improved overall sustainability.

The pre-harvest sector achieved a 10 percent reduction in environmental and social impact between 1970 and 2005 (Fiures 20 and 21). A 12 percent reduction was achieved between 1970 and 2011 (Figures 20 and 21). These improvements were primarily the result of improved efficiency of crop and animal production.

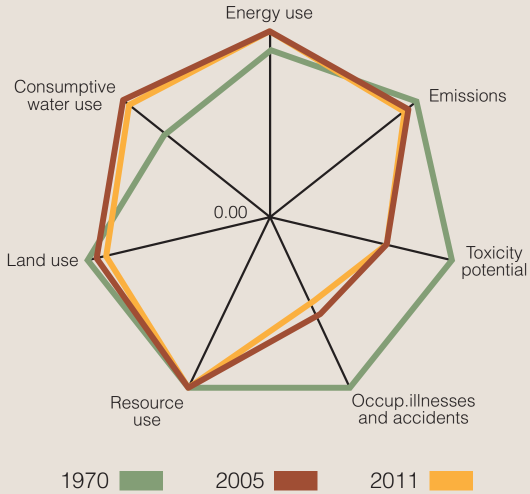


Figure 21 | Environmental Fingerprint for 1970 Pre-harvest Scenario

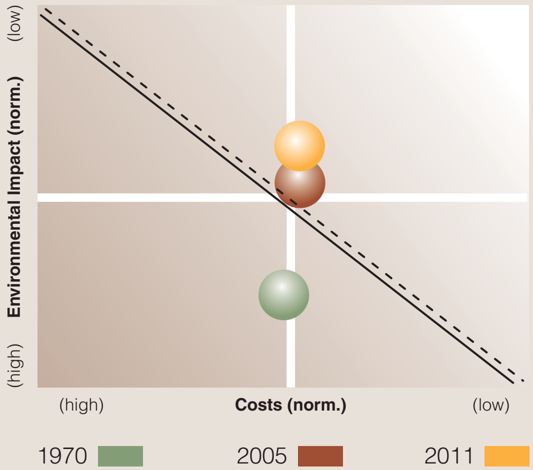


Figure 20 | Eco-Efficiency Analysis Portfolio for 1970 pre-harvest scenario

In some cases an increased impact resulted since the 1970s. This is primarily from increases in crop inputs including fertilizer, energy and water at the MARC. In many instances, the adoption of these practices led to the improvements in efficiency that we see today. For example, the installation of irrigation-driven water and energy use since the 1970s has helped improve crop yields, offsetting other inputs and resulting in an overall improvement of sustainability since the 1970s (Figure 21).

Sustainability Timeline

2005

2006

The United Nations Food and Agriculture Organization released a report titled *Livestock's Long Shadow – Environmental Issues and Options*. This report suggested that livestock are responsible for 18 percent of all manmade greenhouse gases, which is a larger contribution than all of the world's transportation.

2009

Frank Mitloehner, PhD, Associate Professor and Air Quality Specialist in Cooperative Extension, Department of Animal Science, University of California, and colleagues published *Clearing the Air: Livestock's Contribution to Climate Change*, which identified a major scientific flaw in *Livestock's Long Shadow* – an inaccurate and unfair comparison of livestock to transportation.

2010

2010

San Francisco became the first U.S. city to officially declare Meatless Monday, a day to be meat-free in an effort to curb the city's carbon footprint and improve health.

2011

- Dr. Jude Capper, PhD, published *The Environmental Impact of Beef Production in the United States: 1977 compared with 2007*. This checkoff-funded research found modern beef production requires considerably fewer resources than the equivalent system in 1977.
- Sustainability became a "bigger and more complex issue" for the beef industry than just greenhouse gases. Concerns include but are not limited to environment (water, land, air), social (animal welfare, food safety), and economic (profitability, affordability).
- The beef checkoff initiated the U.S. Beef Sustainability Project which is the largest and most holistic sustainability assessment ever attempted for an agricultural commodity.

2013

The checkoff-funded U.S. Beef Sustainability Project was certified by NSF International in July 2013. The pre-harvest segment results were published in the *Journal of Animal Science*.

Next Steps

The Beef Checkoff Sustainability Research Program will work to better understand improvement opportunities identified by the 2011 U.S. Beef Sustainability Project.

2015

Opportunities for Continuous Improvement

The checkoff-funded Beef Industry Sustainability Assessment serves as a guidepost for continuous improvement across the full beef value chain. The industry has demonstrated a commitment to continually improving how beef is produced and is constantly searching for new and better methods to lower its environmental fingerprint while improving its social and economic contributions to communities across the country.

That dedication to improvement has persisted for generations in the United States and it drives the beef industry to look openly at its production practices to find new ways to innovate. The results of the life cycle assessment highlight the industry's significant achievements over time and help identify areas for future progress and innovation. As a result of this work, the beef value chain has identified several target areas to focus its efforts, outlined in Table 2.

These target areas provide high-level opportunities for each segment to contribute to industry-wide improvement. The list is not meant to be exhaustive; instead, it outlines priorities for future improvement identified by the life cycle assessment. There is no one-size-fits-all approach for improvements in beef industry sustainability and each individual along the value chain has a role to play. Increased efficiency is undoubtedly the greatest contributor to increased sustainability and it will continue to be the beef value chain's best opportunity for future progress.

Several of the opportunities for improvement identified in this assessment require additional research to better understand how changes and improvements can be adopted by individual producers. For example, region-specific research is needed to identify management practices and other solutions to help producers evaluate and improve the sustainability of their individual operations.

The realized and existing opportunities table captures factors which are primarily focused on improvements in the environmental metric. However, it is important to note that social sustainability, while not yet well understood, is just as critical to overall industry sustainability and should continue to be a key focus. This is an area where individual efforts at the local level can make a big difference. Local contributions could include, but are not limited to, donations to food banks, participation on school boards, or providing internships and tours for members of the local community.

In addition to further research, there is also a need to capture and quantify some of the less tangible benefits of the beef value chain. These intangibles include important attributes of beef production such as the preservation of open space and wildlife habitat. As the science of life cycle assessments continues to improve over time, improvements being made by the beef value chain may be more fully understood and quantified in the future. That work will further showcase the industry's contributions to responsible beef production.

Table 2 | Realized and existing opportunities by sector

	Realized Opportunities	Existing Opportunities
Crop farm	• Improvements in crop yields • Increased adoption of precision farming techniques • Improved nutrient management	• Continue to improve crop yields • Continued adoption of more water-efficient irrigation systems • Continue to optimize nutrient application to soil
Cow-calf/Stocker	• Higher performing cattle through improved genetics and health • Improved nutrition	• Continue to improve management of cattle and resources to promote improved efficiencies
Feedlot	• Improved cattle performance through better management, nutrition, genetics, health and technology • Improved manure management	• Optimize the use of distillers grains in diets • Continue to improve efficiencies • Continue to optimize manure management techniques to reduce fertilizer inputs
Packer	• Biogas recovery • Closed loop water cooling systems • Waste water recovery	• Continue to optimize biogas recovery systems, closed loop water cooling systems and waste water recovery systems in plants
Case Ready	• Right-size packaging • Plant optimization	• Explore new packing alternatives that further reduce inputs and are accepted by the consumer
Retail	• No improvement in current data	• Provide data to the study • Reduce greenhouse gas leakage from refrigeration units
Consumer		• Reduce food waste

One of the greatest opportunities for improvement is a reduction of food waste. An estimated 40 percent of all food produced in the United States is wasted, contributing to losses in efficiency across the entire food value chain. Food waste costs the average American family approximately $2,500 annually. Although beef waste is about 20 percent of consumable product, it is still a significant burden and represents a major opportunity to improve the sustainability of the beef industry. By cutting beef waste in half, the full beef value chain would achieve an approximate 10 percent improvement in full-chain sustainability.

Conclusion

As the beef industry has improved over time, so too has the value chain's commitment to a more sustainable future. Farmers and ranchers recognize that the succession of multi-generation operations represents an important piece of sustainability's true meaning. However, they also understand that a complete look at beef sustainability requires a more holistic assessment of the industry. Today, the beef value chain has come to define sustainability as the industry's ability to meet growing global beef demand while balancing environmental responsibility, economic opportunity and social diligence.

Whether it is changing grazing patterns to increase weaning weights or the installation of a biogas recovery system at a packing plant, every stakeholder has a role to play in the effort to create a more sustainable beef industry. By uniting to complete the Beef Industry Sustainability Assessment, the U.S. beef value chain has taken a major step forward toward a more sustainable future. It also positions U.S. beef to be a leader in the increasingly important conversation among commodity groups, non-governmental organizations and consumers about how food will be produced in the future.

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