



Sustainability Assessment of U.S. Beef Production

Greg Thoma, Ph.D.,^{1,2} Ben Putman,³ Marty Matlock, Ph.D.,^{3,4} Jennie Popp, Ph.D.,⁵ and Leah English⁵

¹Resilience Services, LLC • ²Department of Chemical Engineering, University of Arkansas • ³Office for Sustainability, University of Arkansas • ⁴Department of Biological and Agricultural Engineering, University of Arkansas • ⁵Department of Agricultural Economics and Agribusiness, University of Arkansas

Background

With increasing public concern and awareness of agricultural sustainability issues, comprehensive methodologies such as life cycle assessment are required to benchmark the beef industry and identify areas of opportunity for continuous improvement. To that end, the Beef Checkoff completed a retrospective sustainability assessment benchmark in 2013 by using Eco-efficiency Analysis to compare the years 2005 and 2011. At the time of the analysis, the methodology used was the most up-to-date and comprehensive – indeed the analysis remains one of the only complete cradle-to-grave assessments of the U.S. beef industry. In 2015, a further refined version of the Eco-efficiency Analysis was completed to incorporate new primary data sources from the beef value chain for the years 2011-2013. As the young and dynamic field of sustainability science continues to evolve, there is a need to adapt and update the methodologies used in life cycle and broader sustainability assessments of the beef industry.

Consequently, this project updated and expanded the original Eco-efficiency Analysis to the SimaPro™ computational platform. The move to the SimaPro™ platform will allow for direct linkages with the Integrated Farm Systems Model (USDA-ARS), which is the simulation model that has been used to generate life cycle inventories from the feed production, cow-calf, and backgrounding/feedlot segments of the beef industry. Additionally, the SimaPro™ platform will allow for even more transparent reporting of our inventories and results to the broader life cycle assessment, sustainability science, and beef communities, which is key to advancing the field and benchmarking beef's sustainability. Finally, this project further expanded the economic sustainability evaluation of the U.S. beef industry to include

the direct, indirect, and induced economic activity and value that is generated from beef production.

Objectives

The objective of this project was to couple farm gate environmental footprints of U.S. beef production systems with post-farm processing and distribution to provide an update to the full Life Cycle Assessment (LCA) of beef production and consumption in the United States. Specifically,

- Adapt the existing LCA to the SimaPro™ computational platform to enable comparison of future performance against the 2011 baseline.
- Collaborate with the USDA-ARS to create links between the Integrated Farm System Model and SimaPro™.
- Expand the economic analysis to include direct, indirect and induced economic activity and value added by regional beef production.

Methods

Life Cycle Assessment is a technique to assess the potential environmental impacts associated with a product or process by compiling a cradle-to-grave inventory of relevant energy and material inputs and environmental releases, evaluating the potential environmental impacts associated with identified inputs and releases, and interpreting the results to assist in making more informed decisions. Broadly, an LCA consists of four stages (**Figure 1**): 1) Define the goal and scope – including appropriate metrics (e.g. greenhouse gas emissions, water consumption, etc.); 2) Conduct life cycle inventories (collection of data identifying system inputs, outputs and discharges to the environment); 3) Perform impact assessment; 4) Analyze and interpret the results.

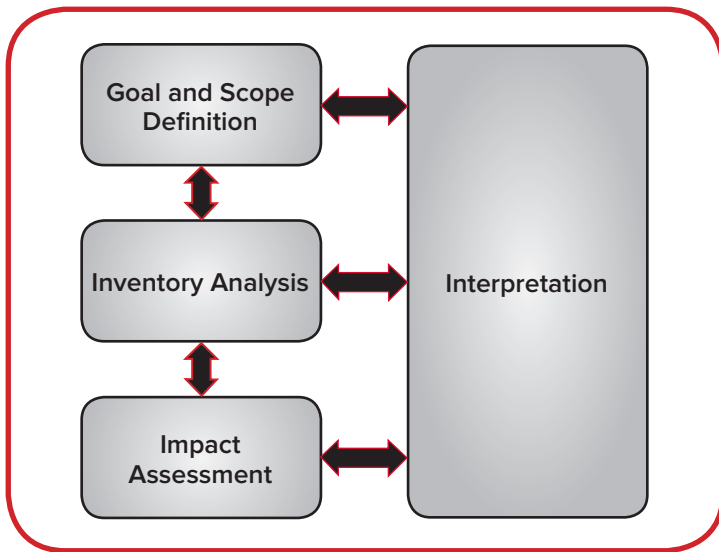


Figure 1. Stages of life cycle assessment (LCA)

We used data available in the first two Eco-efficiency Analysis reports as well as other publicly available data and standard computational approaches to construct a life cycle inventory model of the beef production and consumption supply chain. We replaced proprietary background data with appropriate surrogates from publicly available and transparent lifecycle inventory databases, and we adapted the life cycle impact assessment methodology used by BASF in the original Eco-efficiency Analyses as needed to the SimaPro™ modeling platform.

We used the IMPLAN multi-regional input-output model encompassing numerous aggregated sectors of the U.S. economy with state level economic transaction data to evaluate the contribution of the beef sector (production and processing) to the national economy. The model

provides estimates of the direct (spending by cattle sector enterprises), indirect (non-cattle sector spending from enterprises primarily supporting cattle production), and induced (spending by wage-earning employees in the cattle sector) contributions to the economy.

Important Findings

We reproduced, using transparent and nonproprietary data sources, the major findings from the BASF report. Our results comparing the sector changes between 2005 and 2011 using both the BASF and updated lifecycle model from this work showed significant agreement both in terms of directionality and magnitude.

The relative contribution of each segment of the beef value chain to each impact category (e.g., greenhouse gas emissions, consumptive water use) were largely in agreement with the previous Eco-efficiency Analyses. For example, for both the prior analyses and the current project, 87% of carbon dioxide-equivalent emissions occurred in the pre-harvest segments of the industry, while 13% occurred post-harvest. Identifying where in the beef value chain impacts are occurring is one of the key advantages of LCA and allows the beef community to identify the areas of opportunity along the value chain. In the case of greenhouse gas emissions, the cow-calf segment is the segment with the largest contribution (**Figure 2**), with most of the segment's emissions coming from enteric methane emissions that are a part of the natural digestion process of cattle.

Additionally, LCA allows for an assessment of what impacts are within the control of beef producers, processing and case-ready plant managers, retail and foodservice operators, and consumers, and what impacts lie outside of those individuals' and entities' direct control. For

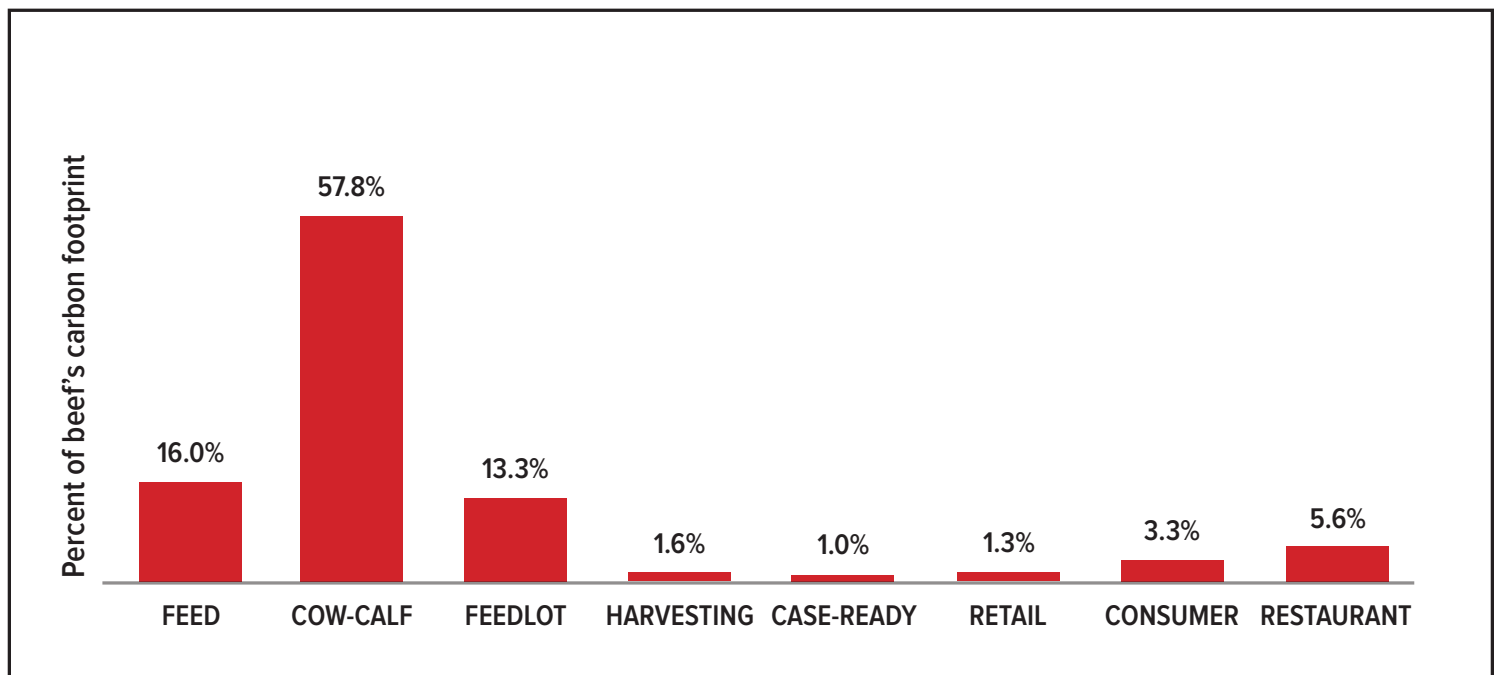


Figure 2. The global warming potential of one pound of edible, consumed beef distributed over each segment of the beef value chain for 2011-2013. Eighty-seven percent of the CO₂ equivalent emissions from beef production occur pre-harvest, with the single largest source of emissions being enteric methane emissions.

example, the fossil fuel combustion required to provide electricity to cow-calf and feedlot operators contributes to the acidification potential associated with beef production; however, beef producers have no control over the primary fuel sources for the electricity they purchase from a utility. Conversely, if a feedlot operator is growing a portion of the crops fed to their cattle, the operator has direct control over aspects that could reduce the impacts of feed production. Examples include changes such as adopting no-till practices, reducing synthetic fertilizer use by utilizing cattle manure as fertilizer, and improving irrigation water use efficiency.

Results of economic analysis show that, in 2014, the beef cattle production and processing industry directly contributed to the employment of nearly 883,000 workers across the United States, resulting in more than \$27 billion dollars in labor income and \$58 billion in value added to the U.S. economy. **When indirect and induced impacts are added, the cattle industry's total contributions to the economy more than double to almost 2.1 million jobs, \$92 billion in income and \$165 billion in value added (Table 1).** In other words, each cattle job generated almost 1.4 jobs in other industries. Each \$1 of cattle industry labor income led to the creation of over \$2 in labor income (often in high paying jobs) elsewhere. Finally, each \$1 generated by the cattle industry led to over \$1.9 added value somewhere else in the economy.

Implications

This work provides the framework for open and transparent assessment of sustainability metrics for the beef industry, and will enable rapid updating of data as well as scenario

Table 1. The direct, indirect, and induced economic contributions¹ of the cattle industry to the U.S. economy

Impact Type ¹	Employment	Labor Income	Total Value Added
Direct Effect	882,862	\$27,600,035,580	\$58,129,513,474
Indirect Effect	506,485	\$27,048,925,921	\$45,677,141,364
Induced Effect	709,756	\$37,263,144,089	\$61,597,775,670
Total Effect	2,099,103	\$91,912,105,590	\$165,404,430,508

¹Direct = spending by cattle sector enterprises, Indirect = non-cattle sector spending from enterprises primarily supporting cattle production, Induced = spending by wage-earning employees in the cattle sector

testing in the future. The new framework will allow data from the Beef Checkoff's regional sustainability assessments to be quickly integrated into the next national sustainability benchmark. This work also established the relative contribution of the beef production sector to the national and regional economies.



The latest beef sustainability assessment evaluated environmental impacts from the entire beef supply chain, including retail.



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For more information, contact:
 National Cattlemen's Beef Association
 Contractor to the Beef Checkoff Program
 9110 East Nichols Avenue
 Centennial, CO 80112
 303.694.0305