The Intersection Between Traceability and Sustainability

Greg Thoma
Ralph E. Martin Department of Chemical Engineering
University of Arkansas
Natural Capitalism

Rocky Mountain Institute
CAPITALISM: The productive use of and reinvestment in capital.

- **Money**—financial capital
- **Goods**—physical or manufactured capital: buildings and equipment
- **People**—human capital: culture and community
- **Nature**—natural capital: natural resources and ecosystem services
First Industrial Revolution

Theory:
People are scarce and nature is abundant—
increase labor productivity.

Result: productivity increase of 100X
Next Industrial Revolution

People are abundant and nature is scarce—
increase resource productivity.
The limits to future profits are...

...fish...

...not boats
Traceability

A growing and wealthier human population is increasing demand for animal-source food (ASF). The livestock sector already uses about 70% of global agricultural land (FAO 2009). Increased demand for ASF will intensify pressure on land, and amplifies the environmental risk to important ecosystem services (Godfray et al. 2010; Foley et al. 2011). To mitigate these effects, it is essential to continue to improve land use efficiency of livestock systems.

• Without appropriate metrics and measures it will be increasingly difficult to identify, adopt or maintain sustainable aquatic livestock supplies
  • Requires collection of and access to high-quality and transparent data regarding material and energy flows through the system
  • May ultimately be the basis for the social license to operate
Sustainability

• Living within our means: resource use efficiency
• Ensuring that future generations of the same opportunity to provide for themselves as we have had.

• Given the recognition that resources are becoming limiting:
  • We must have measures and metrics or we risk failure for future generations
  • Must be able to document and track our progress to understand supply chains-this provides both the rationale for the social license to operate as well as a view to risk management with regard to our ability to continue providing goods and services

• Lifecycle assessment provides a framework for capturing and interpreting these measures and metrics and *ultimately must rely on traceability through the supply chain*

• Disease prevention through efficient recall and safe food has obvious human health benefits that are not fully captured yet in LCA
Introduction to Lifecycle assessment

LCA systematically quantifies inputs and outputs for a system in terms of a standardized unit of measure (FU).

- Product Development / Improvement
  - Selection of best materials or process options (e.g. conservation)
- Identification of ‘hotspots’ for innovation
- Benchmarking
- Product labels / marketing
- Market access (EU/China...)
- Inform public policy

LCA is described in ISO 14040, 14044 and 14046 Standards

ISO International Organization for Standardization
LCA Modelling

• Unit processes: the building blocks of LCA

Key Data Elements to be captured for LCA:
Material and energy flows; emissions; product characteristics.
LCA Modelling

- Life Cycle Inventory (LCI) Analysis

Link to traceability concepts of Critical Traceability Event (supply chain links) And Key Data Elements (i.e. LCI)
ReCiPe and Impact 2002+ Methods

Confidence in Quantitative Results

Decision Support

Normalization and Weighting

Single Score

Simpler, combined metrics support consumer education and communication efforts
We learn quickly that some connections are more important in the supply chain. Potentially very significant added value from traceability to sustainability and communication/education.
Update on NCBA Sponsored LCA of US Beef Production
Region and practice LCA of US Beef Production Systems

- U.S. beef industry is conducting a national evaluation of the sustainability of beef
- Beef cattle production grouped into 7 climatic regions and surveyed to collect management and production practices
- These region-specific production systems are being used to inform a comprehensive national LCA of beef
Cattle Farm Simulations

- Survey responses used to characterize region-specific archetypal beef production systems

- These production archetypes were simulated in the Integrated Farm System Model (IFSM) to determine resource use and emissions

- IFSM simulates all major farm components on a process level including crop production, feed use, and the return of manure nutrients to the land
Modeling Process

• IFSM results used to create LCA models of regional archetypes representing cow-calf, stocker and finishing operations
• LCA models constructed in OpenLCA and provide environmental impacts associated with each production system
• Additional data collected from beef processors and packers used to inform post farm gate supply chain models
Lifecycle Inventory

- Five cow-calf-finisher (CCF) farms in the Midwest region

- All farms assume the same mortality and replacements rates

- In addition to feed grown on farm, all farms:
  - Purchased additional protein (e.g. soybean meal)
  - Rented additional land for corn stover grazing

<table>
<thead>
<tr>
<th>Farms</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Beef farm area</td>
<td>158.0</td>
<td>96.0</td>
<td>375.0</td>
<td>392.0</td>
<td>130.0</td>
<td>ha</td>
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<tr>
<td>Pasture</td>
<td>130.0</td>
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<td>325.0</td>
<td>115.0</td>
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<tr>
<td>Alfalfa</td>
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<td>9.5</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Corn</td>
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<td>6.5</td>
<td>50.0</td>
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<td>15.0</td>
<td>ha</td>
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<tr>
<td>Grain/silage</td>
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<td>Grain only</td>
<td>Both</td>
<td>Both</td>
<td>Both</td>
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<tr>
<td>Corn stover grazing</td>
<td>140.0</td>
<td>80.0</td>
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<td>100.0</td>
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<td>Cows</td>
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<td>200.0</td>
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<tr>
<td>Finish cattle</td>
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<td>32.0</td>
<td>125.0</td>
<td>127.0</td>
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<td>Annual LW sold</td>
<td>144.0</td>
<td>156.0</td>
<td>224.0</td>
<td>210.0</td>
<td>153.0</td>
<td>kg LW/ha</td>
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</table>
Lifecycle impact assessment Results

- Results from five archetypal Midwest CCF farms
- Functional unit: 1 kg of live weight cattle
  - finished cattle and culls
- Large variation in results among similar types of operations within the same region

<table>
<thead>
<tr>
<th>Impact category</th>
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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Unit</th>
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<td>Climate Change</td>
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<td>18.3</td>
<td>15.1</td>
<td>11.0</td>
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<td>Agricultural land occupation</td>
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<td>37.3</td>
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<td>38.7</td>
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<td>Fossil depletion</td>
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<td>0.61</td>
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<td>Freshwater eutrophication</td>
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<td>0.60</td>
<td>0.79</td>
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<td>1.50</td>
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<tr>
<td>Terrestrial acidification</td>
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<td>0.21</td>
<td>0.18</td>
<td>0.16</td>
<td>0.15</td>
<td>kg SO₂ eq</td>
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</table>
Contribution analysis

- Global warming potential results by process contribution
- Differences driven mainly by pasture-related emissions
  - Farm B pasture emits ~8X more N$_2$O per ha than Farm E
- Pasture includes resource use associated with pasture maintenance and emissions resulting from deposited manure and fertilizers
Natural Capitalism, Sustainability and Traceability

• Resources are becoming limiting and we have increased pressure to provide safe, affordable supply of food for a growing population

• Understanding and documenting supply chain transactions, from extraction to disposal, is increasingly important to identify environmental hotspots and for food safety/security.

• LCA is a widely used tool to evaluate sustainability characteristics of products – it requires detailed knowledge of material and energy flows at all stages of the supply chain

• Tools providing traceability along supply chains provide an excellent backbone for collecting and managing information that enables full system evaluation for both sustainability and product recall / food safety concerns.
Life Cycle Thinking

• Think broadly: Life cycle, cradle-to-next-life
• Think deeply: Impacts, endpoints
• Think quantitatively: data; how much of x?
• Think comparatively: what if we change y?
• Assess and systematically document supply chains with:
  standards, transparency, traceability