The primary objective of this study was to calculate the carbon footprint (CO$_2$e) of beef consumption within Boston College Dining Services from May 28, 2017 to May 26, 2018. During the early stages of this project, the Office of Sustainability demonstrated a need to quantify the impact of current beef consumption levels at BC in order to comply with the evolving state-level and national sustainability standards. A vast majority of beef consumed at BC is raised in a conventional system (e.g., grain-fed, finished in feedlots, utilizing growth-enhancing technology), which yields expansive environmental consequences, particularly in relation to climate change inducing greenhouse gas emissions. The primary question of this study was whether or not alternative practices (e.g., grass-fed or locally raised beef production) and beef substitutes would be less carbon intensive than conventional methods and if BC should transition beef procurement and consumption practices to these alternatives.

Methods:
Using BC Dining’s 2017-2018 Sysco Usage report from Juli Stelmaczky, Sustainability Director for BC Dining, we were able to isolate total beef used throughout the academic year by distributor/vendor from a list of 1,629 food products. Through calls with each vendor, along with company website information, we were able to determine whether items originated from grass-fed or grain-fed beef, and in some cases, whether it was locally sourced. To estimate proportion of beef weight from each food item, we used Stelmaczky’s methodology to convert total food product weight to beef weight (e.g., 90 pounds of chicken includes 30 pounds of meat). We found a range of agreement in the literature when determining lbs. of CO$_2$e to use in estimating BC’s carbon footprint from beef. We applied an average lbs CO$_2$e metric derived from the most well-cited sources for conventionally raised (grass-fed) beef systems.

To find a point of comparison for grass-fed systems, we examined a New England-based study that quantified the difference in GHG emissions between production systems as a ratio and applied that ratio to our grain-fed pounds of CO$_2$e factor. We were confident in this factor after observing consistent findings from other sources. To convert from “live” weight, we found literature demonstrating that the consumer benefit found in the dining hall after carcass weight and trimming is removed.

Results:

<table>
<thead>
<tr>
<th>Study</th>
<th>Beef Weight vs. CO$_2$e</th>
<th>CO$_2$e</th>
<th>Livestock</th>
<th>Consumer Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2018</td>
<td>7.40</td>
<td>3.45</td>
<td>50.3%</td>
<td>11%</td>
</tr>
<tr>
<td>April 2012</td>
<td>6.94</td>
<td>3.45</td>
<td>50.3%</td>
<td>11%</td>
</tr>
<tr>
<td>Grass Fed lbs CO$_2$e</td>
<td>21.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass Fed Emissions Factor</td>
<td>1.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass Fed lbs CO$_2$e</td>
<td>14.93</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Approximated CO$_2$E Equivalents for Grass and Grain-Fed Systems

Out of 26 vendors, only three were found to source from grass-fed beef farms, comprising just 11%, or 15,600 lbs. of total beef out of 180,628 lbs. of beef sourced during the 2017-18 collection period. One only vendor, Maine Family Farms, sourced beef locally to Boston College, composing 10,580 lbs., or 5.9% of total beef.

“Cradle-to-Gate” life cycle analyses findings yield an average CO$_2$e of 21.63 lbs CO$_2$e/lb of Consumer Benefit for conventional Grass-fed sources. This includes energy expended in the production of the farm machinery, feed, land, waste, and transportation. Less than 10% of the total CO$_2$e from the beef life cycle results from transportation, making the sourcing location less significant than farm-specific land-use practices.

Grass-fed beef production emissions were found to be higher, at 36.24 lbs. CO$_2$e/lb of Consumer Benefit (Capper 2012). The literature revealed that when using a shorter time horizon in calculating CO$_2$e through GTP30 or GWP100 methods, the increased enteric methane emissions from the cow’s longer growth period on grass-fed without growth hormone exceeded the advantages of pastureland’s role as a carbon sink. This is because a shorter 20 year calculation period lends itself to methane’s shorter residence time in the atmosphere. However, the scope of this project in calculating a CO$_2$e value does not include benefits of local and grass-fed-based systems, such as reduced water use and toxic waste buildup that decreases beef’s ecological impact.

Discussion:

The discrepancies in CO$_2$e estimates between conventional and grass-fed systems may be surprising to the general consumer. Grass-fed has long been considered the ethical and sustainable way to raise beef, but the results of this study suggest otherwise. This is primarily due to the longer time it takes for grass-fed cattle to mature, the increase land use, and the need to graze on marginal land regions (Chapman et al. 2017).

Although the GHG emissions appear to be greater in grass-fed conditions, these systems yield a significant number of positive environmental benefits, including the capacity for carbon sequestration, nutrient cycling, water management, and biodiversity and soil health restoration and preservation (Clark & Tilman 2017).

A key challenge in this study was the lack of transparency between vendors (e.g. processors and distributors) and their clients and consumers. In collecting information via company websites and phone calls, it became clear that the production method, feed type, and geographic sourcing of beef products was not intended for public knowledge.

Eventually, a source from Dans Prize revealed that graded USDA Select beef is assumed to be conventionally-raised, grain-fed beef, validating our final results.

Figure 1: Contextualizing BC Dining Lbs of CO$_2$e from Beef Production

Figure 2: Grass fed vs. grain fed beef sourcing to BC

Figure 3: Beef Supply to Boston College (lbs) categorized by vendor

Figure 4: GHG emissions for beef substitues based on equivalent caloric value

Figure 5: The environmental impacts of a beef system in the USA. The International Journal of Life Cycle Assessment, vol. 24, no. 3, 2018, pp. 441-453, doi:10.1007/s11367-017-1464-6.

References:

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Recommendations:
We recommend that BC increasingly incorporates grass-fed and locally-sourced beef products into their annual supply. This supports the wider transition to more sustainable consumption habits across New England and in institutions across the nation. However, it is clear that any level of beef consumption has a significant carbon footprint, and therefore we suggest that BC also transitions to plant-based food product substitutions. For example, by omitting hamburgeurs on campus for just one day per week, BC would reduce its carbon footprint by 122,717 lbs CO$_2$e.

Figure 4 below illustrates the impacts of substituting the caloric intake of beef for the 2017-2018 year with the same caloric intake of chicken, lentils, and soybeans. Figure 4 demonstrates the advantages in delivering the equivalent caloric benefit with much lower emissions intensity for lentils and soybeans over beef and chicken. This suggests that plant-based options are the primary path to reducing BC Dining’s carbon footprint.

Purpose:

Beef Consumption at Boston College: A Discussion on Carbon Footprint and Alternative Agricultural Practices

Juli Carroll and Curran Clare