Life Cycle Analysis of Beef vs. Soy Production

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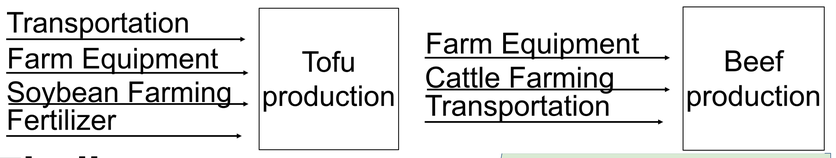
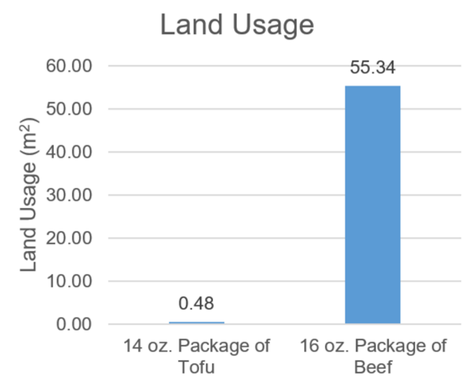
Motivation:

As climate change draws more attention, many people have begun making individual behavioral changes in order to minimize their environmental impact. Recent studies have shown the demand for meat is expected to increase by 70% by 2030 creating a need to focus on the environmental impact and alternative dietary options [3]. Currently, 90% of the beef production in the US is consumed domestically and soybean is the 2nd largest crop in the US [7].This project seeks to quantify the environmental impact of soy and beef based diets. This was accomplished by performing a comparative Life-Cycle Assessment (LCA) to determine the greenhouse gas emissions, oil consumption, energy, land use, and water use of production for a 16 oz. package of beef and a 14 oz. package of tofu.

Study Inputs:

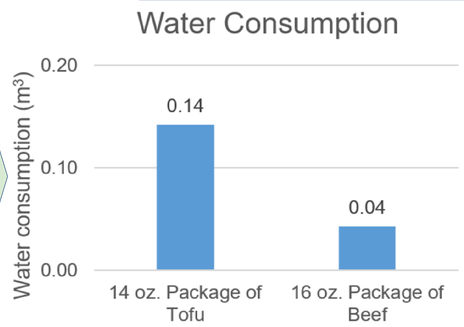


Findings:

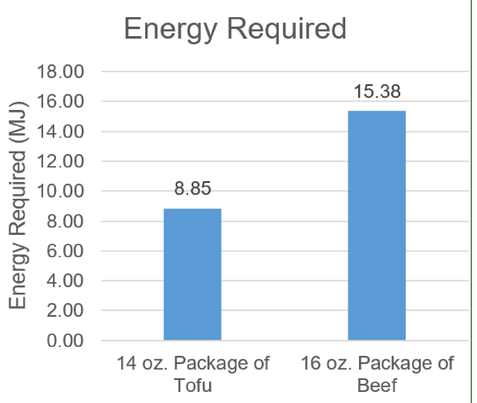


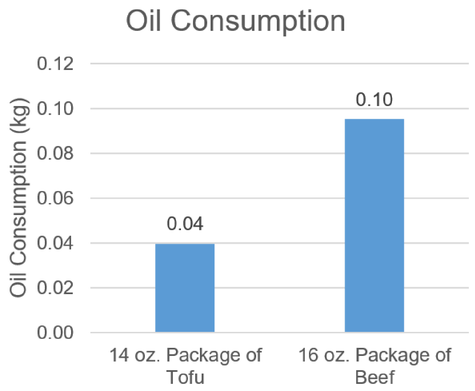
- 1.2 square meters of soybean plants can remove up to 0.17 kg of CO_2 from the atmosphere each year [3]
- Beef land usage is primarily for grazing

- Water usage for tofu includes plant watering
- Water for beef includes animal washing and drinking



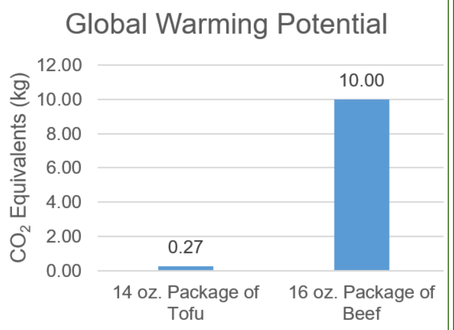
- Energy required includes energy needed for transportation, refrigeration, and machinery used during production





- Oil consumption includes transportation, farm equipment, and machinery used during production

- 0.08 kg of CO_2 equivalents for tofu come from fertilizer production/use
- soybean plants sequester carbon which counteracts emissions [3]
- 57% of beef GWP comes from methane. The majority of the rest come from N_2O released during production [6]



Due to variability between farming practices, an average value for each input was calculated from the statistics found in the research project sources [2]. System boundaries were drawn at the distribution of both beef and tofu products.

Conclusion:

The process for producing a 16 oz. package of beef has a significantly higher environmental impact compared to a 14 oz. package of tofu. These results are consistent with those found in previous studies of the environmental impact of beef and tofu [1][4]. One difference that should be noted is in the LCA study performed by Berardy, water consumption was higher for beef production; a range of 0.13-15.5 m^3 [1]. This is possibly due to inconsistency in how water use is reported and it is often based on varying assumptions [1]. Based on the results, dietary changes which replace beef with soy-based substitutes significantly reduces an individual's carbon footprint. It is important to note that soy-based products may be more expensive and not accessible to everyone. An individual could reduce their environmental impact by simply reducing their beef intake, instead of completely replacing it if that is not possible.

References:

[1] Berardy, Andrew. 2015. "Finding the Future of Food: Sustainable Consumption Lessons from and for Veganism," no. May: 164.
[2]"EIO-LCA: Free, Fast, Easy Life Cycle Assessment." Eiolca, Carnegie Mellon University, www.eiolca.net/cgi-bin/dft/use.pl.
[3] Mejia, Alfredo, Helen Harwatt, Karen Jaceldo-Siegl, Kitti Sranacharoenpong, Samuel Soret, and Joan Sabaté. "Greenhouse Gas Emissions Generated by Tofu Production: A Case Study." Journal of Hunger & Environmental Nutrition 13, no. 1 (January 2018): 131–42. doi:10.1080/19320248.2017.1315323.
[4] Mierlo, Klara Van, Sonja Rohmer, and Johanna C Gerdessen. 2017. "A Model for Composing Meat Replacers: Reducing the Environmental Impact of Our Food Consumption Pattern While Retaining Its Nutritional Value." Journal of Cleaner Production 165: 930–50.
[5] Pelletier, N., N. Arsenault, and P. Tyedmers. "Scenario Modeling Potential Eco-Efficiency Gains from a Transition to Organic Agriculture: Life Cycle Perspectives on Canadian Canola, Corn, Soy, and Wheat Production." Environmental Management 42, no. 6 (2008): 989. doi:10.1007/s00267-008-9155-x.
[6] Presumido, Pedro Henrique, and Sousa, Fernando. "Environmental Impacts of the Beef Production Chain in the Northeast of Portugal Using Life Cycle Assessment." Agriculture, October 19, 2018.
[7] Tichenor, Nicole E, Christian J Peters, and Gregory A Norris. "Life Cycle Environmental Consequences of Grass-Fed and Dairy Beef Production Systems in the Northeastern United States." Journal of Cleaner Production 142 (November 24, 2016). http://rave.ohiolink.edu/ejournals/article/344575922.