Home, Home on the Feedlot

A Study of the Sustainability of Grass-Fed and Grain-Fed Beef Production

By Joseph Portelli

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Introduction

Agricultural practices by themselves require a relatively small amount of energy consumption. However, a closer look at the levels of energy use in all stages of food production, from the manufacturing and transport of farming inputs to the processing and distribution of the final product, reveals that the operation of a food system accounts for a large percentage of energy consumption in countries.[1] Agriculture warrants a high level of attention because if the current trends are correct, there must be plentiful, healthful, and affordable food to sustain a rapidly urbanizing population that could reach 9 billion by 2050. This paper more closely examines the sustainability of agriculture by comparing the production of inorganic grain-fed beef and grass-fed beef because protein is a critical macronutrient for all. An environmental, economic, and health analysis of the inputs to the production of each type of beef shows that a grass-fed operation by management intensive grazing is more sustainable because it is a closed ecological loop while grain-fed beef is ecologically expensive and, contrary to popular belief, economically inefficient.

The Processes

All pieces of grain-fed beef begin their life as steer grazing in a "cow-calf" operation, which prepare the animals for life on the feedlot as part of a concentrated animal feeding operation (CAFO). A CAFO is an agricultural operation that congregates animals, feed, manure, urine, dead animals, and production operations on a small land area (Figure 1).[2] The animal then travels by truck from the ranch to the CAFO so that they can begin weaning, a process to help transition the animals to a diet of grain-based feed. This feed consists of corn, liquefied fat, a protein supplement, and a blend of liquid vitamins, synthetic hormones, and antibiotics, all of which is delivered multiple times per day by the tankful in tractor-trailers.[3] For about 150 days, the animals consume this feed and live in a crowded space filled with manure.[4] Once cattle have reached an age of about 18 to 22 months or 1,100 and 1,250 pounds, they are typically considered "finished" and are transported to packing plants to be slaughtered and processed.[5] The last stage in the process is the transportation of the final product from the packing plant to supermarkets and

[1] In the United States, production, processing, packaging, and distribution of food accounts for 19% of the national fossil fuel energy use. Ziesemer, Jodi. "Energy Use in Organic Food Systems." Food and Agriculture Organization of the United Nations. August 2007. pg. 5.
[2] "What is a CAFO?" Environmental Protection Agency Region 7. http://www.epa.gov/Region7/water/cafo/index.htm
[3] Pollan, Michael. *The Ominvore's Dilemma: A Natural History of Four Meals."* New York: Penguin Group, 2006. pg. 74.
[4] Pollan pg. 78.
[5] "Stages in the Beef Production Process." http://www.beeffrompasturetoplate.org/stagesinbeefproductionprocess.aspx

restaurants. This entire process is industrialized and mechanized so that producers of grain-fed beef can produce the greatest amount of product in the shortest and most efficient time period as possible.

Figure 1. Cows at a CAFO in Iowa. Source: EPA

The production of grass-fed beef, on the other hand, is a process that seeks to imitate natural systems as close as possible. Management intensive grazing focuses on raising grass more than it does on raising cattle because the entire process depends on the health of the grass. Unlike grain-fed beef, young cattle are never weaned and feed continuously on a pasture of diverse grasses throughout their life (Figure 2). An electrified paddock fence powered by a rechargeable car battery encloses a herd of animals, which allows the farmers to keep the animals together and easily move them to a fresh patch of grass daily. Thus, it mimics the natural process of a roaming herd.[6] At the most basic level, grass captures sunlight and converts it to sugars by means of photosynthesis. Plant roots drive the photosynthetic process through the uptake of water and minerals, which naturally infiltrate the ground through pores. Usually, a gravity-driven irrigation system distributes water in addition to natural rainfall.[7] When cattle have reached the right age, usually between 2 and 5 years, grass-fed cattle experience the same slaughter and meat packing process as grain-fed beef.[8] The distribution of the final product varies from operation to operation. While some ship their product out on refrigerated trucks to go to markets or restaurants, many

[6] Pollan pg. 193.
[7] Pollan pg. 194.
[8] Due to government regulations, there are very few small farmers that slaughter and pack their own beef. Sager, Gene. "Where's Your Beef From? Grass-fed Beef: Is it Green, Humane, & Healthful?" *Natural Life*. November/December 2008.

grass-fed beef farmers sell their beef directly from the farm and it is generally distributed only locally.[9]

Figure 2. Cattle at a grass-fed beef farming operation. Source: Mount Vernon Farm.

Environmental Impacts

The production and consumption of grain-fed beef is unsustainable in terms of its environmental impact mostly because the primary input into the process is corn. Hybrid corn, consumes more fertilizer than any other crop[10] and the fertilizer that majority of farmers use today to produce the crop is a product of an incredible amount of fossil fuels. Nitrogen is an essential element because it is the building block of nature. For any crop to utilize nitrogen, of which there are high quantities in Earth's atmosphere, it must undergo a process known as nitrogen fixation because atmospheric nitrogen is nonreactive. Instead of allowing bacteria and legumes to fix nitrogen, however, modern corn farmers use synthetic nitrogen. This synthetic nitrogen combines nitrogen and hydrogen under immense heat and pressure supplied by fossil fuels because coal is burned to generate the heat and pressure while the hydrogen is a derivative of oil, coal, and natural gas.[11] A Cornell ecologist who specializes in agriculture and energy says that due to this dependence on fossil fuels, a typical steer will, in effect, consume 284 gallons of oil in its lifetime.[12] Assuming that 75% of all beef consumption in 2007 in the United States is inorganic

[9] There are some farmers, like Joel Salatain in *Omnivore's Dilemma*, who won't ship their product to long distance destinations because of the use of fossil fuels in transport. This is also the case that I have encountered in many of the grass-fed beef producers in Northwest New Jersey.
[10] Pollan pg. 41.
[11] Pollan pg. 44.
[12] Robbins, John. "What about Grass-fed Beef?" http://www.foodrevolution.com/grassfedbeef.htm

grain-fed beef and that a typical cow weighs 1100 pounds, this translates to a total consumption of over 129 million barrels of oil in a year.[13]

Furthermore, while the synthetic fertilizer allows corn farmers to practice monoculture and thus create economies of scale, the farm no longer needs to remain fertile through biodiversity and rotating crops.[14] Synthetic fertilizer may deliver a yield boost in bushels of corn but it is unsustainable because the chemicals eventually destroy the long term fertility of soils.[15] An additional side effect of using synthetic fertilizer to grow the corn used in grain-fed beef feed is that corn farmers tend to use more synthetic fertilizer than necessary. As a result, the excess chemicals evaporate to form nitrous oxide, a greenhouse gas, or seep into the water table through a layer of soil that has been overfarmed due to monoculture (Figure 3).[16]

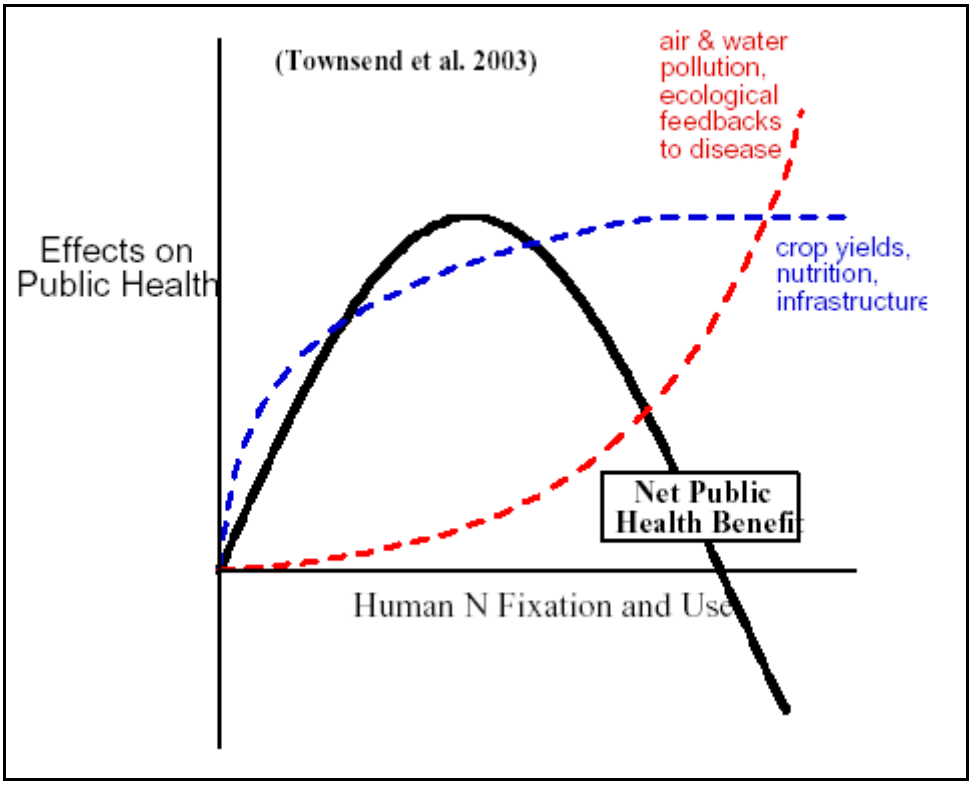

Figure 3. Graph depicting the positive and negative externalities of synthetic nitrogen use. Source: Dr. Ron Nielson

There are additional harmful environmental impacts from the grain-fed process. The process demands a high level of consumption of fossil fuels in the transportation of the cattle at various stages for trucking and refrigerating over long distances. The slaughtering process is also unsustainable in terms of energy usage because workers and automated machines must use high

[13] Personal calculation. [19,159,090 steer * 284 gallons/steer] / 42 gallons/barrel of oil.
[14] Pollan pg. 45.
[15] Pollan pg. 149.
[16] Pollan pg. 46.

pressure hoses that shoot steaming hot water and chemicals. Lastly, the wastes from CAFO feedlots accumulate in manure lagoons (Figure 4). The levels of nitrogen, phosphorus, heavy metal, and hormone residues are so high that the manure cannot be used as fertilizer because it would kill crops. [17]

Figure 4. A manure lagoon at a CAFO. Source: USGS

Although grass-fed beef is slaughtered and packaged in the same way as grain-fed beef, grass-fed beef is more sustainable from an environmental perspective because it actually yields environmental benefits. The pasture on which grass-fed cattle graze is full of a diversity of grasses that not only provide a variety of minerals and organic compounds but it prevents soil erosion because pasture managers do not overfarm or overgraze.[18] As the cattle graze, the grass sheds as much root mass as it loses in leaf and a healthy supply of bacteria, fungi, and earthworms break down this organic matter into humus.[19] Humus is the component of soil that creates a structure to hold moisture and converts soil nutrients into a form plant roots can use to build soil fertility (Figure 5).[20] Organisms maintain fertility and create additional topsoil through this positive feedback loop. Furthermore, cattle expose low-lying clovers when they graze on taller grasses and

[17] Pollan pg. 79.
[18] Pollan pg. 148.
[19] Pollan pg. 196.
[20] Welsh, Dr. Douglas F. "Humus – It's the Dirt!" *Horticulture Update*. July/August 2001.

these clovers naturally fix nitrogen, further building soil fertility.[21] These clovers are legumes that can increase forage intake when ompared to nitrogen fertilized grass, increasing yearly cattle growth by 25% or more.[22] The final benefit in this closed, sustainable loop is that the animal assumes the role of providing basic nutrients in the form of urine and manure as a byproduct of the digestion of grass. If the 16 million acres of land in the United States that are being used to grow corn to feed cows became well-managed pasture, the shift would remove 14 billion pounds of carbon from the atmosphere. This is the equivalent of taking 4 million cars off the road.[23]

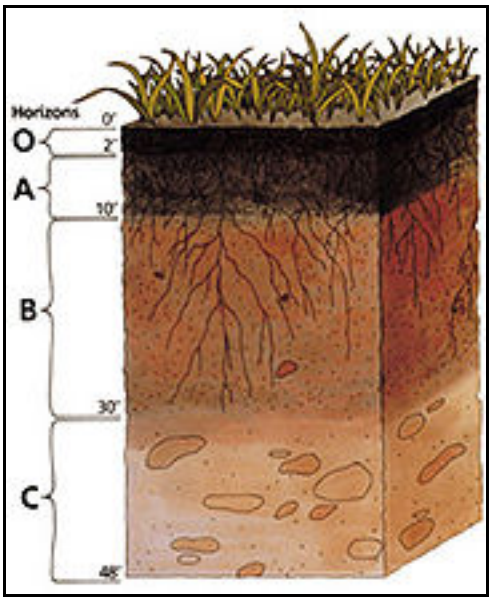

Figure 5. Soil profile diagram with humus shown in darkest layer. Source: Wikimedia

Grass-fed beef is usually locally produced. However, local, in the case of grass-fed beef, does not necessarily mean a 10 minute walk to the grocery store. For example, in suburban New Jersey, some of the closest producers of grass-fed beef are located about an hour away and people can reach the farms only by car. However, farms reduce the impact of emissions because they operate in such a way that a person only has to go to the farm once or twice per season.[24] Despite this, there is still little need for machinery, fertilizer, and chemicals.

An Economic Perspective

If a sustainable process is supposed to be economically as well as physically sustainable, the production of grain-fed beef does not meet this criterion because of all the hidden costs that are associated with the process. The production of corn, the main ingredient in grain-fed beef, is

[21] Pollan pg. 197.
[22] Rayburn, Ed. "Principles of Management-Intensive Grazing." West Virginia University Extension Science. http://www.wvu.ed/~agexten/pubnwsltr/TRIM/5828.pdf.
[23] Pollan pg. 198.
[24] http://www.eatwild.com/products/newjersey.html

arguably one of the most economically unsustainable products currently on the market. Before the surge in production of corn-based ethanol, corn farmers faced falling prices.[25] For farmers to support themselves in the face of falling prices, the only way to generate a substantial cash flow is to produce more corn.[26] Yet, given the fundamentals of supply and demand, this increased production drives down prices even further, leading to a vicious cycle of overproduction. Consequently, payments from the federal government must make up the difference in pricing. 5 billion dollars in federal payments, which come directly from the pocket of the taxpayer, account of nearly half of the income of an average Iowa corn farmer.[27] Furthermore, there are additional environmental and public health costs that burden the American taxpayer that result from water and air pollution.[28]

A new dimension to the cost of grain-fed beef production, however, is the rising demand for biofuels. Faced with rising oil costs and a push to reduce dependency on foreign fuels, competition from manufactures of corn-based ethanol has driven up the price of corn to all time highs.[29] This price increase has raised costs for companies that raise beef on corn-based animal feeds and, as a result, has threatened the affordability of not only beef but also products like milk and eggs. Government aid for biofuel production in the United States and the United Kingdom has further contributed to the rise in price.[30]

Despite the negative environmental impacts and hidden costs, grain-fed beef production system is more profitable than grass-fed beef. The Leopold Center for Sustainable Agriculture at Iowa State University performed a cash flow analysis that showed that grain-fed organic beef has a higher net present value because it commands premiums between 30% and 40% higher than conventional prices. Grass-fed systems, on the other hand, require premiums between 60% and 70% higher than conventional grain-fed systems to generate the same net present value.[31] To succeed in the future, producers of grass-fed beef will have to manage high quality, low cost pastures with high efficiency to create a stronger market presence.[32]

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[25] Iowa State University estimates that it costs roughly $2.50 to grow a bushel of Iowa corn. In October 2005, Iowa grain elevators were paying $1.45. Pollan pg. 53.
[26] Pollan pg. 53.
[27] Pollan pg. 54
[28] Harvey, Graham. "Farming should return to its roots." *BBC News*. January 29, 2008. http://news.bbc.co.uk/2/hi/science/nature/7213348.htm
[29] In April 2008, corn cost $6 per bushel. Moeller, Miriam. "Corn prices reflect trend." *The Mining Journal*. April 11, 2008. http://www.miningjournal.net/page/content.detail/id/508430.html.
[30] Harvey.
[31] Leopold Center for Sustainable Agriculture. "Organic, natural, and grass-fed beef: Profitability and constraints to production in the Midwestern United States." *Leopold Center Progress Report*. Vol. 17, 2008. pg. 58.
[32] Leopold Center pg. 58.

Relationship to Human Health

Grass-fed beef is more sustainable in terms of its benefits to human health because the introduction of corn into the diet of grain-fed feedlot cattle alters its physiology in such a way that the final product threatens food security and becomes nutritionally inferior. Grain-fed beef threatens food security because CAFO operators have to use synthetic hormones and antibiotics to treat the health problems that afflict feedlot cattle as a direct result from their diet of corn, something that cattle have not evolved to consume. Scientists generally acknowledge that the widespread use of powerful antibiotics is leading directly to the evolution of new antibiotic resistant pathogens.[33] Furthermore, the consumption of corn by grain-fed cattle shifts their fatty acid composition to have a higher ratio of Omega-6 (n-6) to Omega-3 (n-3) than normally found in nature. Before the agricultural and industrial agricultural revolutions, human beings evolved on a diet with a ratio of n-6 to n-3 of approximately one. The modern Western diet, of which one component is the large consumption of grain-fed beef, has a ratio of between 15 to 1 and 16.7 to 1.[34] A ratio this high promotes the many degenerative diseases that afflict Americans today, including cardiovascular disease, cancer, and inflammatory and autoimmune diseases.[35] Grass-fed beef, by contrast, contains much higher levels of anti-inflammatory n-3 fatty acids and the cancer-fighting compound CLA while levels of the inflammatory saturated fats are significantly lower.[36] In addition, grass-fed beef is far richer in Vitamin E than grain-fed, which means that its consumption would help prevent a deficiency that scientists have linked with diabetes, immune disorders, eye disease, and lung disease.[37]

Conclusion

The economic and ecological efficiency and the impact on human health of grass-fed beef production through management intensive grazing is an important contributor to agricultural sustainability. Grass-fed beef production by management intensive grazing utilizes solar energy with photosynthesis, improves the cycling of nutrients to improve soil fertility and quantity, and does not compete for fossil fuels. The production of grass fed beef presents itself as an extremely resource efficient and sustainable supply of protein that shows potential for implementation in a

[33] Pollan pg. 78,
[34] Simopoulos A.P. "The importance of the ratio of omega-6/omega-3 essential fatty acids." *Biomedicine & Pharmacotherapy.* Vol 56, 2002. pg. 365.
[35] Ibid.
[36] Robbins.
[37] Ford, Earl S. and Anne Sowell. "Serum alpha-tocopherol status in the United States population: findings from the Third National Health and Nutrition Examination Survey." *American Journal of Epidemiology*, Vol. 150, 1999. pg. 297.

global economy. Assuming a great transfer of knowledge, it may become particularly useful in the global south, where developing nations lack the high level of start-up financial capital to operate industrial, mechanized CAFOs.

References

http://www.eatwild.com/products/newjersey.html.

Agency, Environmental Protection. "What is a CAFO?" http://www.epa.gov/Region7/water/cafo/index.htm.

Agriculture, Leopold Center for Sustainable. "Organic, natural, and grass-fed beef: Profitability and constriaints to production in the Midwestern United States."." *Leopold Center Progress Report*, 2008: 58.

Ford, Earl S, and Anne Sowell. "Serum alpha-tocopherol status in the UNited States population: findings from the Third national Health and Nutrition Examination survey." *American Journal of Epidemiology* 150 (1999): 297.

Harvey, Graham. "Farming should return to its roots." *BBC News.* January 29, 2008. http://news.bbc.co.uk/2/hi/science/nature/7213348.htm.

Pollan, Michael. *The Omnivore's Dilemma: A Natural History of Four Meals.* New York: Penguin Group, 2006.

Rayburn, Ed. "Principles of Management-Intensive Grazing." http://www.wvu.edu/~agexten/pubnwsltr/TRIM/5828.pdf.

Robbins, John. "What about Grass-fed Beef?" http://www.foodrevolution.com/grassfedbeef.

Sager, Gene. "Where's Your Beef From? Grass-fed Beef: Is it Green, Humane, & Healthful?" *Natutral Life*, November/December 2008.

Simopoulos, A.P. "The importance of the ratio of omega-6/omega-3 essential fatty acids." *Biomedicine & Pharmacotherapy* 56 (2002): 365.

"Stages in the Beef Production Process." http://www.beeffrompasturetoplate.org/stagesinbeefproductionprocess.aspx.

Welsh, Dr. Douglas F. "Humus - It's the Dirt!" *Horticulture Update*, July/August 2001.

Ziesemer, Jodi. *Energy Use in Organic Food Systems.* Food and Agriculture Organization of the United Nations, August 2007.