The environmental footprint of beef production
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The sustainability of animal agriculture is currently one of the most highly-debated issues within food production. Consumers often have an ideological view of the perceived advantages of historical small-scale agrarian systems compared to modern agriculture, which, in combination with a renowned desire to understand how food is produced, leads to the supposition that the “good old days” were environmentally superior. Through improvements in genetics, nutrition and management between 1977 and 2007, the U.S. beef cattle industry increased average slaughter weight (1,338 lb in 2007 vs. 1,032 lb in 1977) and overall growth rate (2.60 lb/d in 2007 vs. 1.59 lb/d in 1977) which resulted in the total average days from birth to slaughter being reduced from 609 d (1977) to 485 d (2007). In combination, these productivity improvements resulted in considerable reductions in feed (19%), land (33%), water (12%) and GHG emissions (16%) per lb of beef over the thirty-year time period.

A small yet vocal section of the population advocate for a whole-scale return to the pasture-based production systems that predominated in the first half of the twentieth century within the United States, yet the 135 million acres of increased land required to maintain current U.S. beef production from a wholly pasture-based system would render whole-scale conversion practically impossible (Capper, 2012). If such conversion did occur and annual beef production was maintained at 26.1 billion lb, the increase in carbon emissions would be equal to adding 26.6 million cars to the road per year (Capper, 2012). Pelletier et al. (2010) and Capper (2012) also demonstrated that GHG emissions per unit of beef were greater in pasture-finished systems than in feedlot systems. Pelletier et al. (2010), reported GHG emissions of 19.2 lb CO$_2$-eq/lb liveweight for pasture-finished beef compared with 16.2 lb CO$_2$-eq/lb liveweight for feedlot-finished yearling-fed beef, whereas Capper (2012) reported 26.8 lb CO$_2$-eq/lb hot carcass weight beef for pasture-finished beef and 16.0 lb CO$_2$-eq/lb hot carcass weight beef for feedlot beef.

Several comparative studies have shown beneficial environmental effects of improving productivity (carcass weight and/or growth rate) within the beef sector upon resource use and GHG emissions per unit of beef (Capper, 2012; Capper and Hayes, 2012; Pelletier et al., 2010). However, fertility is arguably the major factor by which global beef producers (specifically cow-calf producers) could also improve the sustainability of beef production. Within the US, 89% of cows bear a live calf each year, and this number declines to between 50% and 60% in the extensive systems characteristic of Brazil, Argentina and Chile. Given that the cow-calf operation contributes up to 80% of GHG emissions per unit of beef (Beauchemin et al., 2010) and that productivity improvements post-calving seldom compensate for the resource use and GHG emissions associated with maintaining a non-productive cow, management practices and technologies that improve pregnancy rate offer significant opportunities. Capper (2013a) modeled the environmental and economic impact of improving calving rate from 60% to the ideal (100%) and demonstrated reductions in land use from 8.92 acres to 6.28 acres, water use from 47 x 103 gallons to 35 x 103 gallons, GHG emissions from 17,516 lb CO$_2$-eq to 12,035 lb CO$_2$-eq and feed costs from $1,924 to $1,412 per 800 lb hot carcass weight beef.

With regards to animal health and sustainability, removing effective parasite control from the cow-calf, stocker and feedlot system resulted in reductions in pregnancy rate (81% vs. 91%), weaning weight (500 lb vs. 547 lb) and overall growth rate (2.43 lb/d vs. 2.89 lb/d), thus increasing total animals (cows, calves, heifers, bulls and steers) per unit of beef by 18%, land use by 16%, water use by 15%, GHG emissions by 13% and economic cost by 12% (Capper, 2013c). The use of productivity-enhancing technologies is also somewhat controversial, yet implants, beta-agonists (βAA) and ionophores have demonstrable benefits in terms of reducing environmental impact and production costs. For example, Capper (2013b) examined the individual and additive effects of implant and βAA use using a whole-system beef model and reported that the greatest environmental mitigation effects were conferred by use of both technologies.

To date, the combined sustainability effects of many of the less-tangible productivity losses within livestock systems, e.g. male fertility, clinical and sub-clinical morbidity and growth of replacement animals have yet to be quantified. The challenge to the beef industry is to build on the culture of continuous improvement in order to maintain and enhance sustainability, not only at the environmental level but also with contiguous gains in economic viability and social acceptability.
References


Capper, J. L. 2013c. The environmental and economic impact of withdrawing parasite control (Fenbendazole) from U.S. beef production. ADSA-ASAS Joint Annual Meeting. Indianapolis, IN, USA. July 8-12, 2013.
