Dairy Sustainability - Using the Real Facts

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Summary

U.S. and global consumers have significant misperceptions about animal agriculture, and in particular, about dairying and dairy products. Two of these misperceptions are that dairy cattle are significant sources of methane and have a large impact on global warming and that cattle compete with humans for food, especially grain. This paper provides quantitative evidence to counter these misperceptions, which can be used to provide factual evidence to consumers that may help them in their life-style choices and their support of government policy and regulations. The evidence also supports the concept that the most sustainable production system is a mixed crop and animal system in terms of minimizing the impact of agriculture on the environment and ensuring an adequate food supply in the future.

Introduction

Sustainability concerns are often viewed as a three-legged stool: environmental, economic, and societal. In animal agriculture, we need to consider animal health and well-being as a fourth leg. While all these concerns are equally important and critical to the future of dairy sustainability, this paper will focus on greenhouse gas **(GHG)** emissions and the carbon footprint of dairy production and the role of dairy in the global food supply with the goal of providing solid facts and numbers that can be used to address consumer concerns about U.S. dairy production.

GHG Emissions and C footprint

The GHG include methane **(CH_4)**, carbon dioxide **(CO_2)**, nitrous oxide **(N_2O)**, and halocarbons. In the atmosphere, these GHG enhance the effects of solar and thermal radiation and can increase surface and atmospheric temperatures. In dairy production, the big 3 GHG are CH_4, CO_2, and N_2O. Methane has several natural sources (termites, wetlands, peat bogs, ocean sediments, and wildlife) and man-made or anthropogenic sources (natural gas production, coal mining, wastewater treatment, landfills, and agriculture). In agriculture, methane is derived from enteric fermentation in monogastric animals as well as ruminants, and anaerobic fermentation in manure storage from all species. With farming, CO_2 is counted only if it is derived from fossil fuel use, including electricity generation. CO_2 emitted from cattle is considered part of the natural, biogenic C cycle as the carbon arises from digestion and metabolism of plant material ingested as feed, and plants derive the carbon from fixing CO_2 in photosynthesis. In agriculture, N_2O arises from internal combustion engines, N fertilization, and manure. GHG emissions are often converted to CO_2 equivalents (CO_2e) that take

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into account the different half-life and radiative forcing of the gases and thus their potential for atmospheric warming.

Myth: cattle are major GHG emitters

Fact: Dairy cattle are a minor contributor to total anthropogenic GHG emissions in the U.S.

Globally, dairy animals contribute only 4% to anthropogenic GHG emissions (EPA, 2011a). There are 1.46 billion cattle around the globe, of which 266 million are lactating cows (FAOSTAT, 2015). In developed countries, the contribution of anthropogenic GHG emissions from dairy cattle is even lower due to increased livestock productivity and dilution by emissions from other sectors (Knapp et al., 2014). In the U.S., dairy cattle operations directly contribute 0.55% to anthropogenic GHG emissions (EPA, 2011b; Knapp et al., 2014), and the entire dairy production chain accounts for less than 2.9% (Thoma et al., 2010; Figure 1). The second number may be an over-estimate due to inclusion of GHG emissions associated with the production of co-product feedstuffs, such as soybean meal and dried distillers' grains and other assumptions made in the life-cycle assessment (Thoma et al., 2010). That study resulted in an estimate of 2.05 lb CO_2e/lb milk, whereas a FAO study (2010) gives ~1.10 lb CO_2e/lb milk.

So why are we concerned about CH_4? It's partly political, partly economic. The U.S. EPA has focused on emissions from CH_4 and N_2O in international policy discussions because they are less expensive to mitigate than CO_2 emissions since CO_2 is associated with fossil fuel use and economic development. Frequently at the farm level, CH_4 mitigation approaches can increase profitability, as well as being environmentally beneficial. Secondly, methane from enteric fermentation and manure comprise more than 40% of the GHG emissions associated with fluid milk production in the U.S. (Thoma et al., 2010). Thus, if we implement strategies to decrease methane per unit of milk produced, we can lower the dairy C footprint. There are good opportunities to further reduce GHG emissions per unit of milk and keep dairy products competitive (Knapp et al., 2011).

With regards to providing an adequate and nutritious food supply, it's more meaningful to look at GHG emissions per unit of product, which is termed methane intensity. In the U.S. and other developed countries, we have the most efficient dairy production systems in terms of GHG emissions per unit of milk (Figure 2).

Fact: Production practices in the U.S. minimize the environmental impact of dairying.

Sustainable Intensification

Globally, it's going to take improvements in production efficiency to produce enough dairy products to feed 9+ billion people in 2050, while minimizing the environmental impact of dairy production. This concept is being called "sustainable intensification" and is typified by dairy production in North America, Europe, Israel and other developed countries. FAO (2011) projects that global demand for dairy products will exceed 1.1 billion tons by 2050 due to increased population and per capita demand, or a 60% increase over 2010 (Cady and Green, 2015). Sustainable intensification has the potential to minimize the impact of increased dairy production on feed, water, and land utilization, as well as reducing GHG emissions per unit of milk. It is possible with existing management strategies and technology to increase milk production while decreasing the number of dairy cows and the feed and water required to support that production. On a global basis, to achieve this would require increasing milk yields by 100 lb/cow/year, which is significantly greater than historical improvements of 22 lb/cow/year but less than the 285 lb/cow/year in the U.S. and other developed countries (Cady and Green, 2015; FAOSTAT, 2015).

Myth: Confined, intensive animal operations are bad for the environment.

Fact: Production efficiencies achieved in intensively managed dairy operations have the lowest environmental impacts in terms of GHG emissions and resource utilization per unit of product.

Unique Role of Ruminants in Our Food Supply

Ruminant livestock have the unique capability of converting large amounts of inedible plant material to edible foods, e.g. milk and meat. Around the world, grazing land exceeds arable crop land by three-fold. Currently in the U.S. ~400 million acres are cropped, whereas there are over 615 million acres of grazing land. In addition to grazing and harvested forages, ruminants have a higher capacity than monogastric animals to utilize by-product feedstuffs.

Human food production generates a significant amount of by-products as part of growing crops and processing (Figure 3). These by-products include crop residues, milling and oilseed by-products from primary processing, secondary products from the baking industry, etc., spent grains from the brewing, distilling, and ethanol industries, animal proteins from the slaughtering and rendering industries, and recycled food waste. From an economic standpoint, many of these byproducts have significant value and thus are termed co-products, but from a human food supply perspective they are by-products.

Myth: Livestock and poultry compete for food with humans.

Fact: The only part of U.S. dairy rations that's potentially edible by humans is grain, which comprises less than 20% of the total feed utilized in dairy production.

By-products typically comprise 20 to 25% of livestock and poultry diets in the U.S. (Figure 4). In dairy production, rations also contain significant amounts of forage. The only part of dairy rations that's potentially edible is the grain, most commonly corn, including the grain portion of corn and small grain silages. The grain in silages is a grey area with regards to edible food. In the Midwest, it is very possible for a farmer to make the decision between chopping corn for silage or harvesting it for grain. However, in the Northeast, the growing season is not long enough to produce corn grain and growing corn silage is the best way to maximize crop yield on land that would otherwise be pasture or forest.

Taking into consideration the amount of feed utilized in replacement heifer, dry cow, and lactating cow diets, the grain portion of dairy rations is less than 20% of the total feed. Given that the majority of the grain is corn, which for consumption by U.S. citizens is largely processed, the net amount of edible food used in dairy feeding is less than 10% (Figure 4). By adding 20% grain into lactating cow diets, milk production is increased by 67%, from 45 lb/day for grazing cows to 75 lb/day for cows fed TMR. It's analogous to a fuel additive that gives you more miles per gallon!

How much by-product feedstuffs are produced in food processing? Over the 2009 to 2013 crop years, an estimated 137.5 million tons (as is basis) of by-products were produced from the primary processing of crops, oilseeds, fruits, vegetables, sugar beets, and almonds, and the net production of human food was 136.7 million tons (Knapp, 2015). Where would these by-products go if they weren't fed to livestock and poultry? They can be disposed of by composting, combusting, and fermenting to generate electricity, tilling back into the soil as an amendment, and landfilling. Composting and combusting can eliminate much of the solid mass, but this occurs with a substantial release of CO_2 into the atmosphere (Russomanno et al., 2012). It seems much better to capture this carbon in meat and milk. Annual U.S. landfill capacity is 134 million tons (EPA, 2013). Thus, feeding by-products to livestock and poultry reduces the C footprint of foods consumed by omnivores, vegetarians, and vegans. In essence, the most efficient food production system is a mixed crop and animal system.

Fact: Production and processing of primary crops for human consumption in the U.S. generates as much by-products as it does edible food.

World-wide, by-products from grain and oilseeds generate 410 million tons of feedstuffs each year, with another 1890 tons of crop residues available for feed (Knapp and Cady, 2015). With continued increases in crop yields, it's conservatively estimated that there will be 574 million tons of by-products and 2640 millions tons of crop-residues available in 2050. This amount of feed can go a long way towards feeding livestock without compromising the food supply for humans, and in combination with improvements in animal agriculture, can provide an adequate supply of food for the global population without compromising the environment. The use of by-products reduces the need for grain feeding and results in more food available for humans. There is a double benefit achieved in utilizing by-products in animal feeding, first, by sparing grain for human consumption, and secondly, by converting inedible feedstuffs to highly nutritious, edible animal products.

Conclusions

In this age of electronic communications, consumers have access to lots of information regarding agriculture and food production. However, not all of it is factual. To be prepared with facts and provide them openly when consumers seek them is in the best interest of all of us who are engaged in animal science and agriculture.

References

Cady, R.A. and H. Green. 2015. Meeting 2050 global milk demand while freezing the environmental footprint of dairy production. Abstract submitted for the 2015 ADSA-ASAS Joint Annual Meeting. http://adsa.org.

EPA. 2011a. DRAFT: Global Anthopogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030. USEPA #430-D-11-003.

EPA. 2011b. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009. USEPA #430-R-11-005.

EPA. 2013. Municipal Solid Waste (MSW) in the United States: Facts and Figures 2008-2012. http://www.epa.gov/epawaste/nonhaz/municipal/msw99.htm.

EPA. 2015. Draft: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013. USEPA #430-R-15-xxx.

FAO. 2010. Greenhouse Gas Emissions from the Dairy Sector: A Life Cycle Assessment. P. Gerber, T. Vellinga, C. Opio, B. Henderson, and H. Steinfeld. Rome, Italy.

FAO. 2011. World Livestock 2011 - Livestock in food security. Rome, Italy.

FAOSTAT. 2015. FAO Statistics Division. http://faostat3.fao.org/download/Q/QA/E.

Knapp, J.R. 2015. Co-existence: Edible Foods vs. Inedible Feeds in Our Food Production System. Submitted to Feedstuffs.

Knapp, J.R., and R.A. Cady. 2015. Crop and grazing land requirements to meet consumer demand for animal products in 2050. Abstract submitted for the 2015 ADSA-ASAS Joint Annual Meeting. http://adsa.org.

Knapp, J.R., J.L. Firkins, J.M. Aldrich, R.A. Cady, A.N. Hristov, W.P. Weiss, A.D.G. Wright, and M.D. Welch. 2011. Cow of the Future Research Priorities for Mitigating Enteric Methane Emissions from Dairy. Innovation Center for U.S. Dairy. http://www.usdairy.com/Public%20Communication%20Tools/CowoftheFutureWhitePaper_7-25-11.pdf.

Knapp, J.R., G.L. Laur, P.A. Vadas, W.P. Weiss, and J.M. Tricarico. 2014. Invited Review: Enteric methane in dairy cattle production: Quantifying the opportunities and impact of reducing emissions. J. Dairy. Sci. 97:3231-3261.

Russomanno, K.L., M.E. Van Amburgh, and R.J. Higgs. 2012. Utilization of byproducts from human food production as feedstuffs for dairy cattle and relationship to greenhouse gas emissions and environmental efficiency. Pp. 130-145, Cornell Nutrition Conference Proceedings.

Thoma, G., J. Popp, D. Nutter, D. Shonnard, R. Ulrich, M. Matlock, D.S. Kim, Z. Neiderman, N. Kemper, C. East, and F. Adom. 2010. Greenhouse Gas LCA for Fluid Milk. The Innovation Center for U. S. Dairy. http://www.usdairy.com/Sustainability/Science/Pages/Science-Layout-2. aspx.

USDA Economic Research Service. 2015. Economic Research Service Dairy Data. http://www.ers.usda.gov/data-products/dairy-data.aspx.

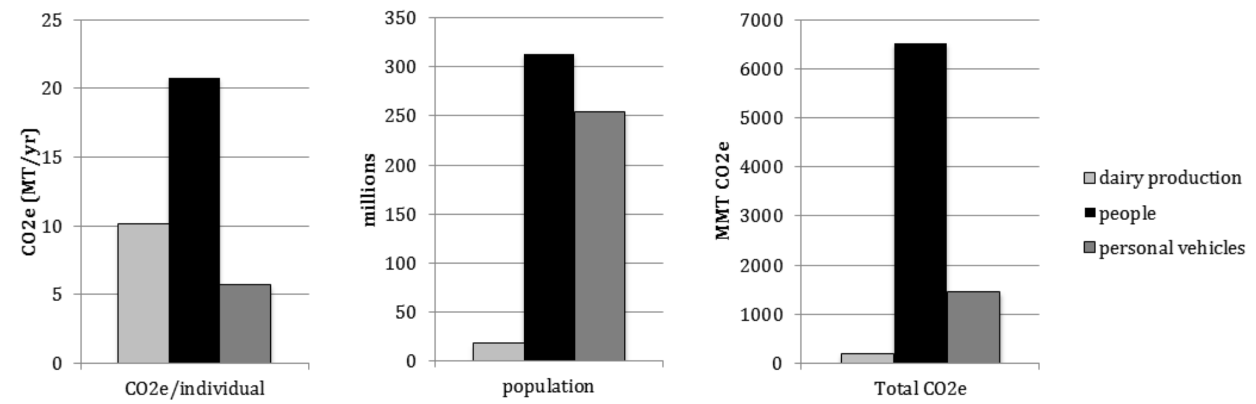

Figure 1. CO_2e from dairy production and personal vehicles compared to 2012 total anthropogenic emissions in the U.S. Dairy production includes the entire chain from farm to consumer and is based on 9.235 million lactating cows + 9.2 million replacement heifers. Data from Thoma et al., (2010), EPA (2013), and USDA-ERS (2015). MT=metric tonne, and MMT=million metric tonnes.

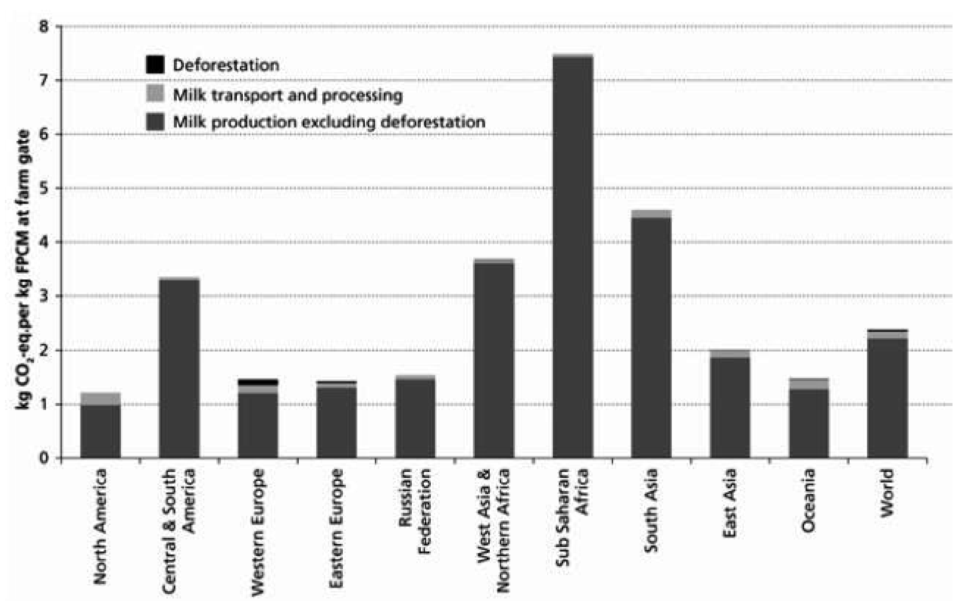

Figure 2. GHG emissions per unit of milk for different regions around the world (FAO, 2010).

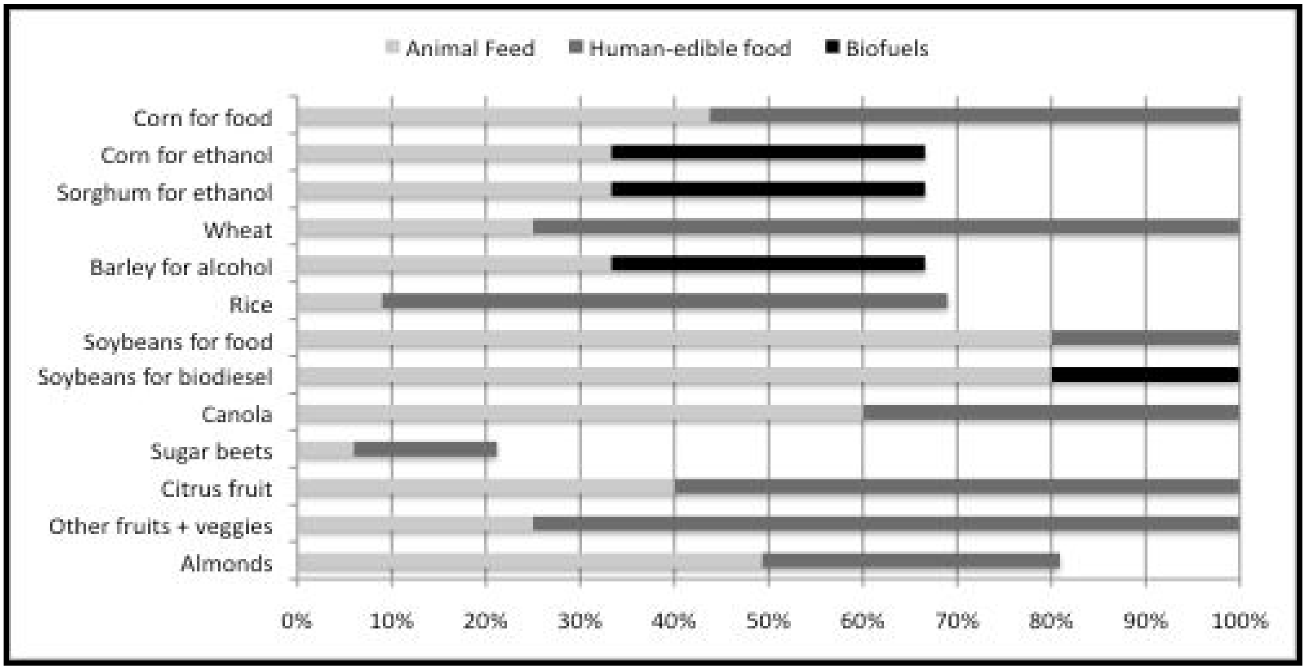

Figure 3. Proportion of by-product animal feeds generated when crops are processed for human food or biofuels. In certain cases, the products of crop processing do not add to 100%. Fermentation to ethanol results in 33% loss of grain mass as CO_2. With rice, sugar beets, and almonds, the discrepancy represents rice hulls, water loss, and almond shells, respectively.

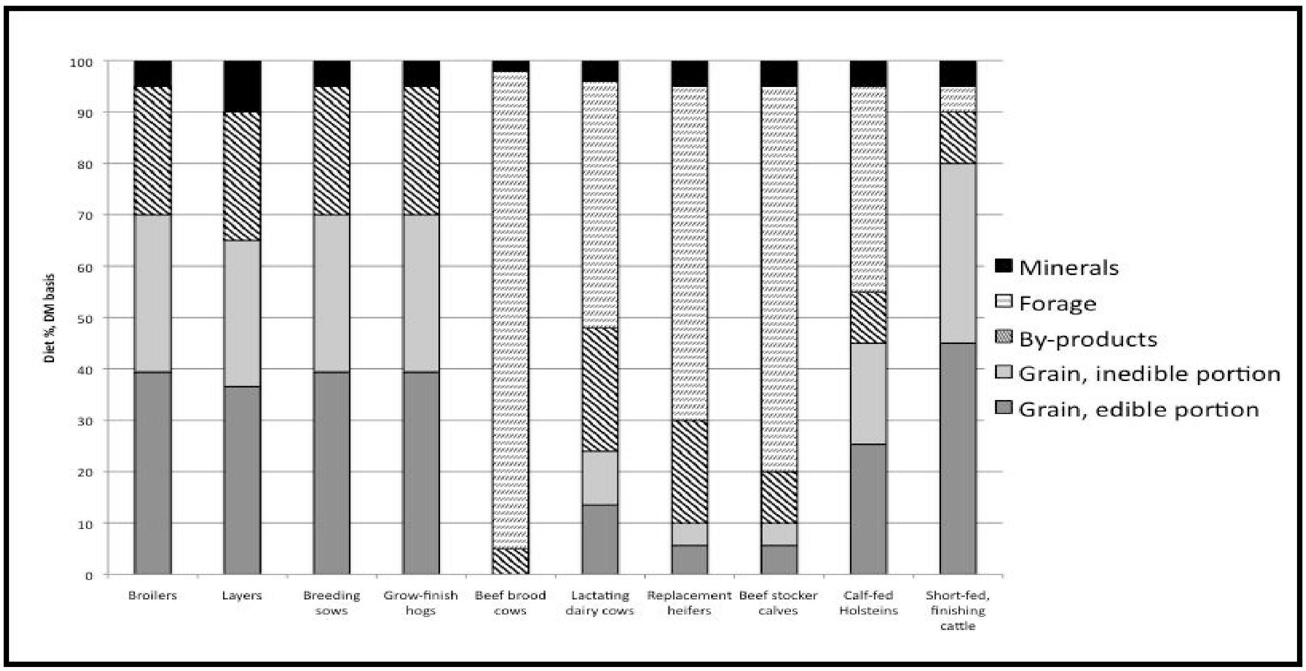

Figure 4. Proportions of grain, by-products, and forage in typical commercial U.S. livestock and poultry diets, dry matter basis.