

REDUCING THE EMISSIONS INTENSITY OF LIVESTOCK PRODUCTION: CASE STUDIES OF SUCCESS

GLOBAL
RESEARCH
ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

USA

Scale: National
System: Housed
Sector: Dairy

Reducing the intensity of enteric methane emissions from the US dairy herd

In 2014, the US national dairy herd produced twice as much milk with around 60% less cows than 90 years ago. These productivity gains – achieved through continuous improvements in animal genetics, nutrition, and management – have halved the enteric methane emissions per unit of milk produced in the US.



Intensive dairy farm in the Western United States (courtesy: A.N. Hristov, The Pennsylvania State University)

Background

The United States is one of the world's largest producers of milk and dairy products. The US dairy industry is estimated at USD\$140 billion in economic output, USD\$29 billion in household earnings, and more than 900,000 jobs. Inevitable by-products of the industry are greenhouse gases (GHG) such as methane and nitrous oxide. Dairy methane emissions from enteric fermentation and manure management represented about 11% of the total methane emissions, and nitrous oxide emissions from manure management represented about 1.6% of the total nitrous oxide emissions in the US in 2013 (US-EPA, 2015). US dairy farmers have been steadily improving the efficiency of milk production, which in turn has resulted in a dramatic improvement in enteric methane emission intensity.

Key actions & their effects on productivity, income & food security

One of the most feasible and practical ways of decreasing GHG emission intensity from animal agriculture is through increasing animal productivity. The US dairy industry is an excellent example of the impact this can have on emissions intensity.

Dairy cow productivity in the US has been steadily increasing – 14% in the last decade alone and over fivefold since 1924 (Figure 1), the first year dairy statistics were reported by USDA. At the same time, the size of the US dairy herd has decreased to about 43% of that in 1924. Modern dairy cows are larger and consume more feed, which results in higher enteric methane emissions per cow – about 2.5 times more in 2014 vs. 1924 (based on USEPA, 2015 emission factors for 1990–2013, extrapolated to 1924). However, the intensity of enteric methane production has dropped from about 31 g/kg milk in 1924 to 14 g/kg in 2014 (Figure 2). This progress has been driven by continuous improvements in animal genetics, nutrition, health, management and free market mechanisms.

As an example, based on the Council on Dairy Cattle Breeding data, the Milk Breeding Value for US Holstein cows has increased from -7,758 in 1960 to 463 in 2013, which means an improvement in milk yield of 70 kg/yr. For the same period, milk production increased from 3,195 to 9,916 kg/cow/yr, or 127 kg/yr. Thus, approximately 55% of the increase in milk yield can be attributed to improvement in animal genetics. Similar improvements have been achieved in crop production and animal nutrition. For example, yield of corn grain in 1960 was around 3.5 tonnes/ha, compared with 10 tonnes/ha in 2013. For the same period of time, yield of corn for silage increased from around 16 tons/ha to 43 tonnes/ha.

Figure 1: Milk production per cow in the US

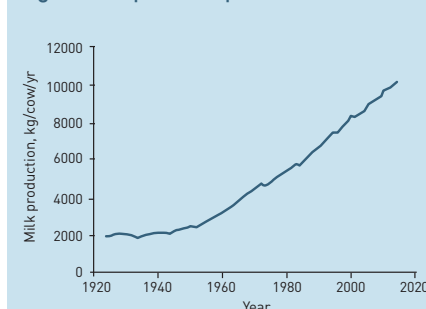
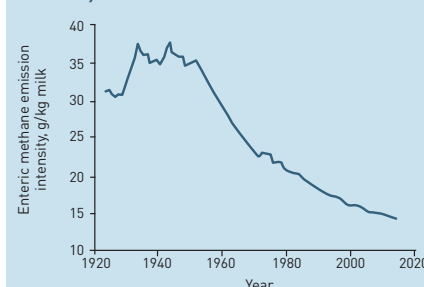


Figure 2: Intensity of enteric methane emissions from dairy cows in the US





Milking parlor of a large dairy farm (courtesy: A.N. Hristov, The Pennsylvania State University)

Effect of actions on emissions intensity of livestock production

These gains in animal productivity have led to a leap in feed efficiency, which in turn resulted in a 55% decrease in enteric methane emission intensity. It is logical that methane emissions per animal have increased in 2014, compared with 90 years ago. For example, based on extrapolated USEPA (2015) emission factors, a dairy cow emitted around 60 kg enteric methane/yr in 1924, whereas in 2014 an average dairy cow emitted 144 kg/yr. This large difference is explained by the larger size and much greater milk yield of the modern Holstein cow. Both of these factors contribute to greater feed dry matter intake, which is driving enteric methane emissions in ruminant animals. Total enteric methane emissions have increased by about 5-6% in 2014 compared with 1924, an equivalent of close to 71 million tons of methane per year. For the same period of time, however, milk production from the US dairy herd has increased by a factor of 2.3 to reach close to 94 million tons in 2014. If this amount of milk had to be produced by cows with 1924 emission intensity, there would be an additional 1.6 million tons of methane emitted to the atmosphere, essentially more than doubling the current enteric methane emissions from dairy cows in the US.



Intensive dairy farm in the Eastern United States (courtesy: A.N. Hristov, The Pennsylvania State University)

Co-benefits and trade-offs

A co-benefit of the increased productive efficiency of dairy cows in the US is the advantage of having less total manure produced as a result of the reduction in national herd size. This carries benefits such as reduced manure ammonia, methane, and nitrous oxide emissions. Manure emissions per animal have likely increased due to the greater amount of manure excreted and decreased feed digestibility observed with increasing dry matter intake, but this may be partially or fully counterbalanced by improved crop genetics and digestibility. The large increase in crop productivity, which is closely associated with animal production, has also resulted in improved efficiency of land and water use for feed and food production. However, intensification of animal production is not without a penalty. For example, the productive life of dairy cows in the US is around or slightly less than three lactations and cow pregnancy rates have been declining since 1960s.

Implications for adaptation

Enhanced efficiency of milk production will likely have no effect on adaptation to climate change per se. On a system level, however, better crop and animal genetics and improved animal productivity and efficiency are beneficial in terms of food security. Housed dairy production systems may also offer advantages in adapting animals to a changing climate.

Challenges to implementation and adoption

In spite of the relatively small proportion livestock emissions contributes to total GHG emissions in the US (about 5.1% in 2013), livestock producers, including dairy farmers, are striving to improve efficiency of milk or meat production and reduce the carbon footprint of their industries. The main challenges faced by the US dairy sector that can be related to intensification are improving animal health and reproduction. The reproductive efficiency of the modern Holstein dairy cow in the US has been decreasing in the last decades, although upward trends in breeding values for daughter pregnancy and cow conception rates have been observed in recent years. These trends are encouraging and indicate that the negative impact of aggressive selection for milk yield can be reversible, while retaining the benefit of decreased GHG emission intensity.

Further information

USDA-ERS:

<http://www.ers.usda.gov/data-products/dairy-data.aspx>

US-EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2013:

<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>

Council on Dairy Cattle Breeding:

<https://www.cdcb.us/eval/summary/trend.cfm>

USDA-NASS:

http://www.nass.usda.gov/Newsroom/2011/04_26_2011.asp

Contact:

Alex Hristov, Penn State University
anh13@psu.edu or +814 863 3669