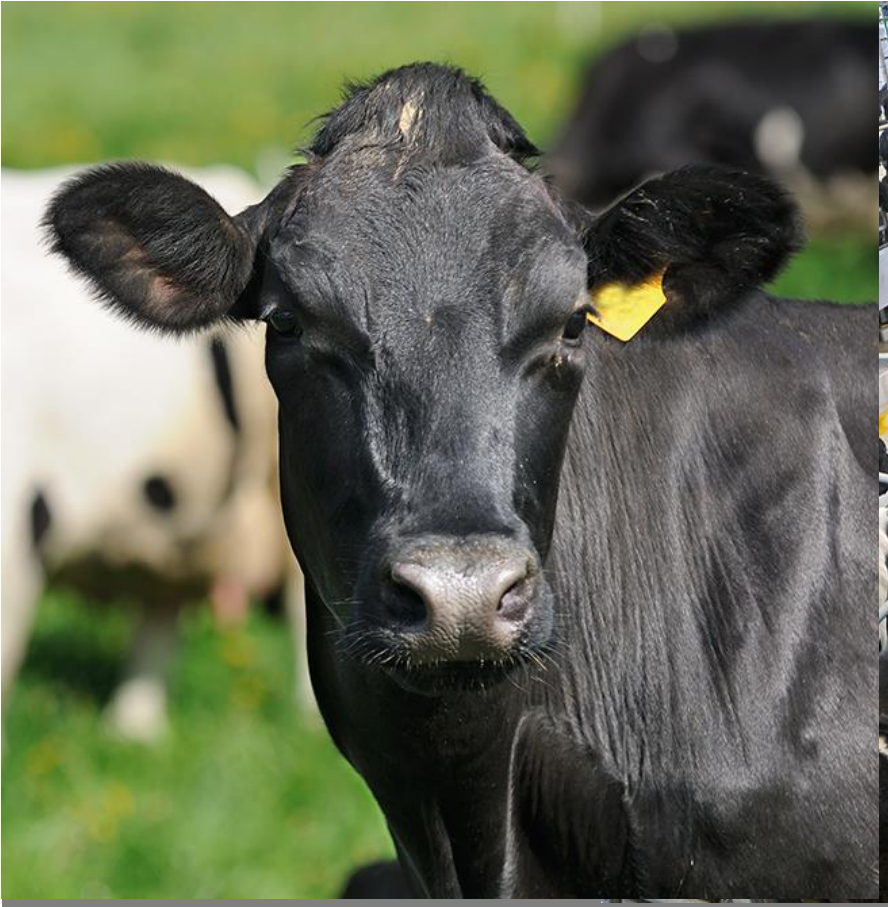


Environmental Benefits of Modern Dairy, Hay, and Forage Production Technologies

AEM
Association of Equipment Manufacturers

NMPF
NATIONAL MILK PRODUCERS FEDERATION

DFA
Dairy Farmers of America

The overarching objective of this project was to **quantify the environmental benefits of modern dairy, hay & forage production technologies** in the U.S. and Canada.

Consumers, dairy farmers and cows are all better off as a result of modern dairy practices

1970s.. to today,

Dairy farmers have become more sustainable, with advances in cow care, nutrition, genetics and technology. Milk production in the US has nearly doubled despite fewer cows[1].

As of 2021, US dairies

- Contribute 3.5% of the US GDP[2]
- 3,300,000 jobs[2]
- $42 B in direct wages[2]
- $67 B in federal, state and local taxes[2]

By 2050,

As part of a stewardship pledge to consumers, the dairy industry is pursuing a voluntary goal to achieve greenhouse gas neutrality by 2050[1].

Consumers today have more options than ever before

- rbST **vs** No rbST
- Organic **vs** Conventional
- Fat free **vs** full fat
- Lactose free **vs** Not
- Many others…

The FDA ensures that all options are safe for consumers, backed by extensive research

Dairy farmers are ensuring that they go above and beyond to provide milk that is responsibly produced

A healthy and happy cow is a high producing one. It is in the farmers best interest to ensure maximum comfort to the cow with minimal external stresses.

FARM[3] (Farmers Assuring Responsible Management) program ensures customers **360-degree responsible stewardship** of dairies and milk production. 99% of all US milk comes from cows participating in the FARM program.

1. Animal Care
2. Environment
3. Antibiotics
4. Workforce development
5. Biosecurity

Source: [1]Midwest Dairy, [2]IDFA, [3]National dairy farm

10 common myths and misconceptions about modern dairy practices

1. Cows in a barn are less happy than those that are out in a field.

Through the measure of stress hormones, it has been shown that cows are more comfortable inside the barn where they are in a controlled climate rather than being exposed to the elements in the field.

Source: Journal of Dairy Science

2. Humans don't need dairy in their diets.

At one-point humans were unable to consume dairy after a certain age. However, we experienced a genetic change about 7500 years ago that now allows us to. In fact, the USDA now recommends between 1 to 3 cups of dairy a day.

Source: University College London, USDA

3. Juices and other milk alternatives are healthier than milk.

One 8 oz. glass of milk contains two times the number of vitamins and nutrients of a comparable glass of juice.

Source: Journal of Dairy Science

4. Modern milking is uncomfortable for the cow.

Modern milking equipment offers many advantages including fully robotic and other automated technology whereby the needs of the animal are monitored to provide a gentle and complete milking process.

Source: The Washington Times

5. Dairy alternatives are more environmentally friendly.

The ratio of CO_2 per gram of protein produced is far lower in dairy milk than in the milk alternatives.

Source: UN Food and Agriculture Organization

6. Dairy milking is not a very technologically advanced industry.

Dairy farms today now have several technologies including robotic milking systems that allow cows to milk themselves. Farmers are also able to monitor cow health using a "Fit bit" for cows.

Source: The Washington Times

7. Cows are harmful to the environment.

Cow manure contains nutrients than can be applied to other crops reducing the need for synthetic fertilizers. Methane gas produced by cows can be used to help generate electricity.

Source: US Dairy Alliance

8. Dairy cows are pumped full of antibiotics.

Antibiotics are only used on an as needed basis and can only be administered by a veterinarian. When a cow is given antibiotics, the cow and her milk are separated from the rest of the herds', until it has left her system.

Source: Journal of Dairy Science

9. Farmers don't care about their cows.

A healthy cow is the number one priority for any dairy farmer. Healthy and happy cows are productive ones.

Source: Farmers Assuring Responsible Management

10. Cows compete with humans for food.

A Cow's diet consists mainly of hay and forage which is farmed on land that is not suited for other crop production. The contents of the feed rations that they are fed are not appropriate for human consumption.

Source: Journal of Nutrient Management

10 benefits of dairy and the practices associated with modern dairy production

The US dairy industry accounts for **3.3 million jobs**.

Source: National Farmers Union

Over the last quarter century dairy has **reduced its carbon footprint by 63%,** water usage by 65%, and methane production by 57%.

Source: Journal of Dairy Science

Today the U.S. dairy industry **produces more milk than in 1944** with 16 million fewer cows.

Source: Journal of Dairy Science

The **U.S. dairy industry accounts for 3.5% of GDP**. For comparison, the entire automotive industry accounts for 3%

Source: National Farmers Union

97% of the over 34,000 U.S. dairy farms are **family owned and operated**.

Source: US Dairy Alliance

Dairy is an **excellent source for 12 of the essential nutrients** needed for healthy living.

Source: Dairy Council of CA

Dairies **produce manure which is used as organic fertilizer**. One 750 cow dairy farm can produce enough manure fertilizer to cover 2,700 acres.

Source: Dairy Cattle Extension

Consuming dairy may help with heart health, **lower blood pressure and a possible reduced risk of Type II Diabetes**

Source: American College of Cardiology

New technologies allow farmers to **capture methane** and convert it into electricity.

Source: Bloom Energy

Dairy is **less reliant on the weather** than other areas of agriculture. This allows for year-round production and a reliable food source.

Source: Journal of Dairy Science

Near infrared (NIR) sensors have enabled a revolution in feed technology that has made dairy feed consistently better over time.

- *In addition to livestock genetics, the **FEED RATION AND QUALITY IS THE GREATEST DETERMINANT** of milk quality and yield.*
- ***LIVESTOCK FEED CONSISTENCY CAN VARY TREMENDOUSLY** in quality due to different growing conditions, species grown, maturity at harvest, fertilization practices among other factors.*

TRADITIONALLY forage is tested multiple times during harvest.

- 15-20 samples sent for lab testing **a season**
- Measure dry matter, protein, energy content, nitrogen concentrations.
- **Time consuming** process

With the advent of Near Infrared (NIR) Sensors

MODERN forage harvesters have the ability to test forage as its being harvested

- >4000 samples **per second** on board the machine
- Measure dry matter, protein, energy content, nitrogen concentrations.
- **Instantaneous** process

This has enabled:

Better quality feed | ***Higher milk yields*** | ***Better prices for farmers*** | ***Lower feed waste***

This is one of the many ways that dairy farming has been significantly improved in the last two decades by the adoption of modern technology to improve outcomes

Executive Summary

HIGH LEVEL DRIVERS OF DAIRY PRODUCTIVITY OVER THE LAST FEW DECADES

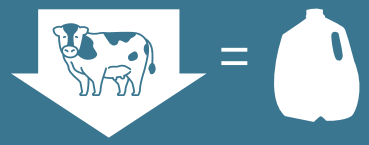
Deeper Insights	Farmers today have a deeper insights into their operation that enables **better decision making**. Whether it's the health of the animal, contents of feed/milk, or the overall productivity of the herd, Data is driving more decisions on the farm than ever before.
Genetic Selection	The improvements driven by better genetic selection of cows is **far reaching and has been a major contributor** to the overall productivity increase in the industry. Cow longevity, feed utilization, milk production and disease resistance are all parameters that have improved as a result of this.
Larger Scale Dairies	The average herd size is twice as large in 2020 as it was in 2003. This has resulted in an intensification of production practices. The financial advantages associated with economies of scale enable larger farms to weather difficult times better than smaller farms.
Knowledge Sharing	The internet and social media has reduced the barriers to information sharing between farmers. This cross-pollination of ideas has enabled the spreading of best practices across geographies.

Modern dairy, hay & forage production technologies have been major enablers of the drivers of productivity

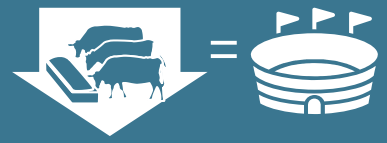
COMPARED TO 2007,

THE RESOURCE OPTIMIZATION THAT TECHNOLOGY ENABLES TODAY HAS LED TO:

930,000 less cows to produce the same amount of milk



Reducing feed enough to fill **3,200** NFL football stadiums



Reduced need for cropland roughly equal to the state of **Maryland**

GHG emissions improvements equivalent to taking **4,000,000 cars** off the road permanently

Water savings each year that is enough to supply New York City for **2 years**

Source: DairyHerd, USDA ERS, Context Analysis

North America has far outpaced rest of the world in milk productivity. North American cows produce **4 times** as much as the global average.

FIGURE 1.1: GLOBAL MILK YIELD 1960-2020

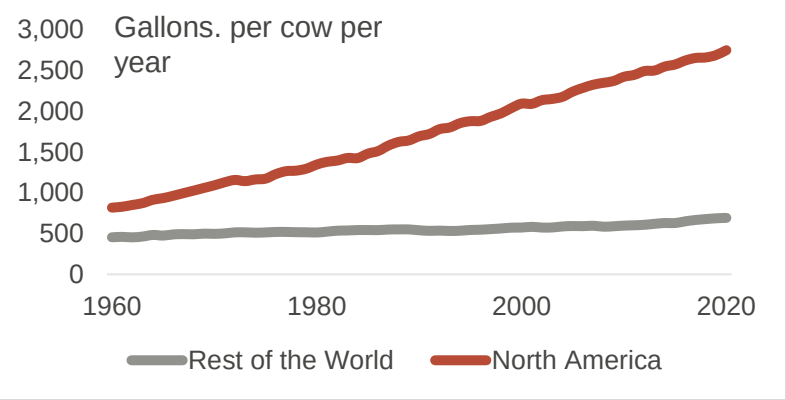
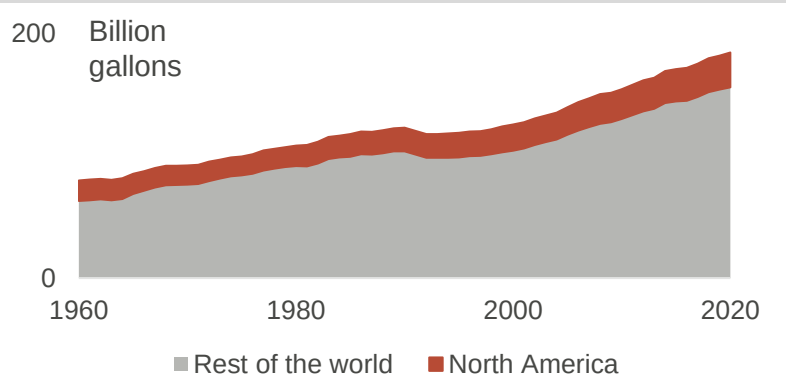


FIGURE 1.2: GLOBAL MILK PRODUCTION 1960-2020



IMPROVEMENTS

- North America produces **~15%** of the all the milk produced in the world with only 4% of the world's cows
- Between 1960 & 2020, North American milk yield has increased **3.5 times** while the rest of the world has increased only 1.5 times.
- As of 2020, North American dairy cows produce **four times** as much milk as the global average

CONTRIBUTING FACTORS

- **Genetics**
  Intensive genetic selection for milk yield and desirable traits associated with it.
- **Technology**
  On farm technological innovations that have improved the productivity with which farmers are able to operate. E.g., robotic milking
- **Farm management practices**
  Management practices that focus on aspects like cow comfort, heat abatement, air quality, among many others etc.
- **Other factors**
  Innovations around the health care of animals for e.g., effective vaccines, feed additives etc.

Source: FAO, USDA ERS, Context expert insights

Summary of results from the environmental benefits study owing to **ALL FACTORS**: genetics, technology, farm management practices & other factors

From 2007-2021, North American dairy has observed the following benefits

North American cows are now able to do more with less. Yielding 19% more since 2007.

19% Milk Yield

15% Feed usage

Efficiencies in land use brought about over the last decade has reduced the land needed per lb. of milk produced

26% Land use

17% GHG emissions

Water use for irrigation, sanitation and cow consumption has reduced on a per cow basis

10% Water use

Not quantified: Animals today are far more comfortable due to technological advances leading to higher milk yields.

Feed quality

Better Animal health

Reduced unskilled labor

On a per cow basis

Feed use per cow has reduced 15% in the last 15 years as a result of advances in genetics & tech

GHG emissions per cow has reduced significantly owing to advances in technologies that mitigate emissions.

Not quantified: Feed quality has improved greatly, owing to cross-benefits in nutrient uptake that benefit yield and feed use.

Not quantified: Automation and mechanization has reduced the need for unskilled labor

Summary of results from the environmental benefits study due to **TECHNOLOGY** only

From 2007-2021, North American dairy has observed the following benefits

North American cows are now able to do more with less. Yielding 6% more as a result of TECHNOLOGY since 2007.

6% Milk Yield

On a per cow basis

4% Feed usage

Feed use per cow has reduced 4% in the last 15 years as a result of TECHNOLOGY

Efficiencies in land use brought about over the last decade has reduced the land needed per lb. of milk produced

13% Land use

8% GHG emissions

GHG emissions per cow has reduced significantly owing to advances in TECHNOLOGY.

Water use for irrigation, sanitation and cow consumption has reduced on a per cow basis

6% Water use

Not quantified: Feed quality has improved greatly, owing to cross-benefits in nutrient uptake that benefit yield and feed use.

Feed quality

Not quantified: Animals today are far more comfortable due to technological advances leading to higher milk yields.

Better Animal health

Reduced unskilled labor

Not quantified: Automation and mechanization has reduced the need for unskilled labor

The following are the improvements in *per cow* productivity levels that are directly a result of **technological** advances in dairy, hay & forage production technologies

Per cow..	How much it equates to per year..	Put in Context, Compared to 2007,	Contributing factors..
6% gain in **milk yield**	**5** Billion gallons of milk	 **930,000** fewer cows needed to **produce the same amount of milk**	Activity monitors, testing of milk, genetic improvement and feed quality, TMR feed mixers, advanced feeders, storage, robotic milking, precision agriculture
4% less in **feed use**	**112** Billion lbs. of feed	 **Feed enough to fill 3,200** NFL football stadiums	TMR feed mixers, better + more consistent quality feed/formulation, feed storage, advanced feeder systems, activity monitors & RFID tagging
13% less in **land use**	**7.2** Million acres of land for feed	 The land mass roughly **equivalent to the state of Maryland**	Auto guidance, section control, variable rate, telematics, more productive cows
8% less in **GHG emissions**	**61** Billion lbs. less CO_2e produced each year	 **4 Million cars off the road permanently**. ~1-2% of all cars in the US	Higher feed utilization, better feed quality, feed processing, Methane digesters, manure collection technologies, manure processing etc.
6% less in **water use**	**3.6** Trillion Liters of water	 **Enough water for NYC** for **2 years**	Systemic water saving processes in manure management, precision irrigation, water use tracking,

While the industry has improved significantly, continued improvements into the future hinge on continued technology adoption and genetic improvements

Given the improvements the industry has observed over the last 15 years, there is the **potential** to continue this into the future

Resource intensity of the following	From 2007-2021 Aggregate improvement	From 2022-2030 Aggregate improvement	From 2022-2030 Improvement due to technology
= Milk Yield	19%	11%	3%
Feed use Intensity	- 15%	- 19%	- 6%
Land use Intensity	- 26%	- 9%	- 4%
GHG Emission Intensity	- 17%	- 19%	- 8%
Water use Intensity	- 10%	- 4%	- 3%

If, the industry continues with its current trend of resource efficiency, in 2030, milk will be produced with **1.3M** fewer cows as compared to 2021

The future improvements in the industry hinge on the sustained innovation that has led to where the industry is today:

- Continued technology adoption
- Integration of Artificial intelligence
- Carbon credits for progressive practices
- Continued improvements in genetics
- Superior tracking and traceability
- Superior animal health interventions
- Next generation feed additives
- Precision irrigation adoption

How do we get to full adoption?

Policies that reward innovation

Grow farm income

→ Capital to invest in operations

Improve enabling infrastructure

→ Wireless over croplands

Improve consumer communication

→ Build trust in science


Thank
You
CONTEXT
AEM
Association of Equipment Manufacturers
NMPF
NATIONAL MILK
PRODUCERS FEDERATION
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Dairy Farmers of America