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

**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**

By 2050, as part of a stewardship pledge to consumers, the dairy industry is pursuing a voluntary goal to achieve greenhouse gas neutrality by 2050¹.

- Contribute 3.5% of the US GDP²
- 3,300,000 jobs²
- $42 B in direct wages²
- $67 B in federal, state and local taxes²

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.

**As of 2021, US dairies**

- Contribute 3.5% of the US GDP²
- 3,300,000 jobs²
- $42 B in direct wages²
- $67 B in federal, state and local taxes²

**FARM³ (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:** ¹Midwest Dairy, ²IDFA, ³National dairy farm

**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 cows¹.

As of 2021, US dairies

- Contribute 3.5% of the US GDP²
- 3,300,000 jobs²
- $42 B in direct wages²
- $67 B in federal, state and local taxes²

By 2050,

As part of a stewardship pledge to consumers, the dairy industry is pursuing a voluntary goal to achieve greenhouse gas neutrality by 2050¹.
# 10 common myths and misconceptions about modern dairy practices

<table>
<thead>
<tr>
<th>1. Cows in a barn are less happy than those that are out in a field.</th>
<th>2. Humans don’t need dairy in their diets.</th>
<th>3. Juices and other milk alternatives are healthier than milk.</th>
<th>4. Modern milking is uncomfortable for the cow.</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>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.</td>
<td>One 8 oz. glass of milk contains two times the number of vitamins and nutrients of a comparable glass of juice.</td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Dairy alternatives are more environmentally friendly.</th>
<th>6. Dairy milking is not a very technologically advanced industry.</th>
<th>7. Cows are harmful to the environment.</th>
<th>8. Dairy cows are pumped full of antibiotics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ratio of CO₂ per gram of protein produced is far lower in dairy milk than in the milk alternatives.</td>
<td>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.</td>
<td>Cow manure contains nutrients that can be applied to other crops reducing the need for synthetic fertilizers. Methane gas produced by cows can be used to help generate electricity.</td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A healthy cow is the number one priority for any dairy farmer. Healthy and happy cows are productive ones.</td>
<td>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.</td>
</tr>
<tr>
<td>Source: Farmers Assuring Responsible Management</td>
<td>Source: Journal of Nutrient Management</td>
</tr>
</tbody>
</table>
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

- **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

- **Consuming dairy may help with heart health, lower blood pressure and a possible reduced risk of Type II Diabetes.**
  
  Source: American College of Cardiology
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

**MODERN** forage harvesters have the ability to test forage as it is 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

### 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.

---

**HIGH LEVEL DRIVERS OF DAIRY PRODUCTIVITY OVER THE LAST FEW DECADES**

<table>
<thead>
<tr>
<th>Driver</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deeper Insights</td>
<td>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.</td>
</tr>
<tr>
<td>Genetic Selection</td>
<td>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.</td>
</tr>
<tr>
<td>Larger Scale Dairies</td>
<td>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.</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>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.</td>
</tr>
</tbody>
</table>

---

**COMPARSED 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.

**IMPROVEMENTS**

- North America produces ~15% of 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

- **19%** Milk Yield
- **15%** Feed usage
- **26%** Land use
- **17%** GHG emissions per cow
- **10%** Water use
- **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.
- Water use for irrigation, sanitation and cow consumption has reduced on a per cow basis

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

**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.**

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

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

- **Feed quality has improved greatly, owing to cross-benefits in nutrient uptake that benefit yield and feed use.**

- **Automation and mechanization has reduced the need for unskilled labor.**

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

**On a per cow basis**

- **6% Milk Yield**
- **4% Feed usage**
- **13% Land use**
- **8% GHG emissions**
- **6% Water use**

**Not quantified:** Animals today are far more comfortable due to technological advances leading to higher milk yields.
The following are the improvements in *per cow* productivity levels that are directly a result of technological advances in dairy, hay & forage production technologies:

<table>
<thead>
<tr>
<th>Per cow..</th>
<th>How much it equates to per year..</th>
<th>Put in Context, Compared to 2007,</th>
<th>Contributing factors..</th>
</tr>
</thead>
<tbody>
<tr>
<td>6% gain in milk yield</td>
<td>5 Billion gallons of milk</td>
<td>930,000 fewer cows needed to produce the same amount of milk</td>
<td>Activity monitors, testing of milk, genetic improvement and feed quality, TMR feed mixers, advanced feeders, storage, robotic milking, precision agriculture</td>
</tr>
<tr>
<td>4% less in feed use</td>
<td>112 Billion lbs. of feed</td>
<td>Feed enough to fill 3,200 NFL football stadiums</td>
<td>TMR feed mixers, better + more consistent quality feed/formulation, feed storage, advanced feeder systems, activity monitors &amp; RFID tagging</td>
</tr>
<tr>
<td>13% less in land use</td>
<td>7.2 Million acres of land for feed</td>
<td>The land mass roughly equivalent to the state of Maryland</td>
<td>Auto guidance, section control, variable rate, telematics, more productive cows</td>
</tr>
<tr>
<td>8% less in GHG emissions</td>
<td>61 Billion lbs. less CO₂ produced each year</td>
<td>4 Million cars off the road permanently. ~1-2% of all cars in the US</td>
<td>Higher feed utilization, better feed quality, feed processing, Methane digesters, manure collection technologies, manure processing etc.</td>
</tr>
<tr>
<td>6% less in water use</td>
<td>3.6 Trillion Liters of water</td>
<td>Enough water for NYC for 2 years</td>
<td>Systemic water saving processes in manure management, precision irrigation, water use tracking,</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Resource intensity of the following</th>
<th>From 2007-2021</th>
<th>Aggregate improvement</th>
<th>From 2022-2030</th>
<th>Aggregate improvement</th>
<th>Improvement due to technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Yield</td>
<td>19%</td>
<td></td>
<td>11%</td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>Feed use intensity</td>
<td>- 15%</td>
<td></td>
<td>- 19%</td>
<td></td>
<td>- 6%</td>
</tr>
<tr>
<td>Land use intensity</td>
<td>- 26%</td>
<td></td>
<td>- 9%</td>
<td></td>
<td>- 4%</td>
</tr>
<tr>
<td>GHG Emission intensity</td>
<td>- 17%</td>
<td></td>
<td>- 19%</td>
<td></td>
<td>- 8%</td>
</tr>
<tr>
<td>Water use intensity</td>
<td>- 10%</td>
<td></td>
<td>- 4%</td>
<td></td>
<td>- 3%</td>
</tr>
</tbody>
</table>

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 we get to the future: Barriers to adoption

### How do we get to full adoption?

<table>
<thead>
<tr>
<th>Policies that reward innovation</th>
<th>Grow farm income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Capital to invest in operations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Improve enabling infrastructure</th>
<th>Improve consumer communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>➔ Wireless over croplands</td>
<td>➔ Build trust in science</td>
</tr>
</tbody>
</table>
Thank You