100 Years of Milking: From Buckets to Robots

Hand Milking 1880-1920

• 4 cows milked/hr
• 8 cows/farm
• 40 acres with ¼ to feed Horses
• ½ of US population lives on Farms
  – 12M farm workers in 1915, 1M in 2015
• Life Expectancy 54 yrs
Make hay while the sun shines

Bucket Milking

• 10 cows/hr
• 20 cows/farm
• 80 Acres
• Tractors!

Well-Water Milk Cooling
What came first?

Pipeline Milking

• 30 cows/hour = 60 cows = 240 acres
• Classic Red barn and Silos
• Milking Ergonomics
Parlor Milking

- 50 – 150 cows/hour
- Hired milking labor
- Cows Step up
- Milking Ergonomics
- Semi-Automated

Count the rings on the tree
Rotary Milking Parlors
Cows move people stand still
100+ cows/person/hour – highly repetitive work

Multiple Barns with Large Parlor(s)
We Need to Talk about Robots

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A political ecology of robots is due, one that is rigorously empirical, dedicated to justice and animal welfare, but unromantic in every regard.

This is a surreal cyborg affair, but the animals are clearly experiencing less physical stress than their counterparts at dairies around the state. Equally, the owner tells me that this technological innovation has allowed him to maintain and raise wages for his very small remaining workforce and has freed time for him to see his grandchildren, and indeed spend more time attending to his cow. Rather than having to oversee an army of workers to march hundreds of animals to the milking parlor in the middle of the night in January, he can tend his animals directly.

What the animal’s experience might be is beyond our capacity to know. It is definitely the case, however, that the animals have increased autonomy and freedom of movement, less structured schedules, and lower stress, all resulting in higher yields. This may not compare to a pastoral ideal, but it certainly represents a radical change in trajectory from the massive and stressful milking parlors of past decades.

Growth in Robotic Milking

World and US Growth rate has been EXPONENTIAL!!

300+ Farms in US  500+ in Canada

![Estimated AMS farms worldwide](image)
Robotic Milking: Single Box Systems
50-70 Cows per box

“Family Farm” = 4-8 boxes
200 - 500 cows

Robots (and Cows) on Pasture
DeLaval Automatic Milking Rotary™ (AMR™)
24 stalls - 5 arms Cows Rotate, Arms Stationary
Batch or voluntary milking

GEA Dairy Pro-Q Rotary Robotic Parlor
1 arm per stall Arms rotate with cows
Batch Milking 1 Operator Monitoring Operations
Manage by Pen or by Cow

The Future?
Small Farms with Robotic Boxes
Large Farms with Robotic Boxes
Large farms with Robotic Rotaries
Future Scenario: Fixed arm rotary

What could possibly go wrong?

Cows in the WA with one cow blocking the entrance
Future Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Cows / arm</th>
<th>Cows / milking labor unit</th>
<th>Feed Management</th>
<th>Milking Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Farm</td>
<td>-</td>
<td>150</td>
<td>Individual Cow</td>
<td>Fixed Interval</td>
</tr>
<tr>
<td>Big Farm</td>
<td>-</td>
<td>250</td>
<td>Pen</td>
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<tr>
<td>Robotic Box</td>
<td>60 70</td>
<td>240 480</td>
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<td>Variable Interval Unattended</td>
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<tr>
<td>Robotic Rotary Stationary arms</td>
<td>150 225</td>
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<td>Robotic Rotary Moving arms</td>
<td>15 40</td>
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</table>

Agricultural Economy in Wisconsin

- 12% of employment
- 11% of total income
- 16% of industrial sales
- Relative importance of agriculture has diminished as service sector employment has grown
Market Sector Trends

- **Strength and Growing**
  - Butter
  - Dry dairy products
  - Meat

- **Strength & Declining**
  - Cheese

- **Weak & Declining**
  - Fluid milk
  - Ice cream

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It’s a World Market

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The Importance of Trade

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MILK PRODUCTION
Wisconsin, 1926-2016

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UW Center for Dairy Profitability
Mark Stephenson, PhD
Director of Dairy Policy Analysis
WISCONSIN DAIRY FARMS

As dairy crisis crushes farmers, Wisconsin's rural identity in jeopardy

Grist mills, car dealerships and hardware stores suffer. The local tax base erodes. Churches and schools struggle or close.

"The multiplier effect on the rural economy is huge. It’s why you are seeing all these boarded-up small towns," Peck said.

Wisconsin lost 500 dairy farms in 2017, and about 150 have quit milking cows so far this year, putting the total number of milk-cow herds at around 7,600 — down 20% from five years ago.

Shares of cows per size classes

Distribution in IFCN standard classes 1996-2014

**India**
- Herd size change 1996-2014: 2.0 — 1.7
- Annual % change in herd number: 2.8%

**Brazil**
- Herd size change 1996-2014: 9.0 — 22
- Annual % change in herd number: -2.3%

**USA**
- Herd size change 1996-2014: 72 — 182
- Annual % change in herd number: -3.4%

**IFCN Projected World milk production growth through 2025**

Absolute and % change in milk volumes 2025 vs 2014 mill t ECM

**ECM**: Energy Corrected Milk; 4% fat, 3.3% protein
A good cow in 1936
(8,000 lb/yr, 3600 kg/yr)
Land Value Pressure on Traditional Dairy Areas

AGRICULTURAL LAND VALUES: AVERAGE VALUE PER ACRE, WISCONSIN, 2013-2017 1/

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm real estate 2/</th>
<th>Cropland</th>
<th>Pasture</th>
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<tr>
<td>2013</td>
<td>4,100</td>
<td>4,010</td>
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<tr>
<td>2014</td>
<td>4,400</td>
<td>4,350</td>
<td>2,150</td>
</tr>
<tr>
<td>2015</td>
<td>4,700</td>
<td>4,700</td>
<td>2,250</td>
</tr>
<tr>
<td>2016</td>
<td>4,750</td>
<td>4,900</td>
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<tr>
<td>2017</td>
<td>5,200</td>
<td>5,200</td>
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1/Value at which the land could be sold under current market conditions. 2/Value includes land and buildings.

Farms Entering the Information Age

FARM COMPUTER USAGE: WISCONSIN, 2007-2017

<table>
<thead>
<tr>
<th>Year</th>
<th>Farms with computer access</th>
<th>Farms using computer for farm business</th>
<th>Farms with Internet access</th>
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<tbody>
<tr>
<td>2007</td>
<td>69</td>
<td>38</td>
<td>58</td>
</tr>
<tr>
<td>2009</td>
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<tr>
<td>2017</td>
<td>77</td>
<td>49</td>
<td>73</td>
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The Immigrant Labor Situation

Some dairy farms hire full-time immigrant workers, many of whom are undocumented. In 2008, 40 percent of Wisconsin’s dairy workforce were immigrants—up from just 5 percent in 1998, reported the Wisconsin Center for Investigative Journalism. Their numbers have been even higher at larger dairy operations.

Dairy farm operators report difficulty finding reliable U.S. born workers willing to fill these new positions. As a result, there are at least 5,300 immigrant workers on Wisconsin dairy farms, more than 40 percent of all hired employees. The majority of these workers are of Mexican or Hispanic origin. Failure to resolve the debate on federal immigration policy may have an impact on dairy producers in this state.

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Cost of Milk Production: Wisconsin

- Cost of Production: $27/cwt
- Value of Production: $19/cwt
- COP-VOP: -$8/cwt
- COP – Operating Cost: $3.2/cwt

- Robotic Milking
  - Increased Capital cost
  - Modest decrease in hired labor
  - Shift to higher skilled jobs
  - Must have increased productivity to be viable
    - More milk per cow
    - Better cow health and longevity
    - Reduced vet cost, labor turnover

The Cows Appear to Like Them

"Satisfied? I warned you not to invite the cows in for a few drinks."
100 Years of Milking: From Buckets to Robots

Douglas J. Reinemann
Associate Dean: Extension and Outreach
Professor: Biological Systems Engineering
Director: Milking Research and Instruction Lab