Success Factors for Managing and Building Box Robotic Dairies

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Robotic Milking Worldwide

- ± 20,000 dairy farms with robots, mostly 50 to 300 cow dairies in Western Europe, Canada, and the US Northeast.

- 95% Lely and DeLaval single box systems.

- Fullwood, BouMatic, SAC/Insentec, GEA, single, double and small multibox systems.

- Differences are much bigger than in parlor technology.
Robotic milking is popular on small dairies

**Lifestyle**
Flexible hours, less physical, more interesting work for the family.

**Economic**
A modern, labor efficient parlor is underutilized, costs almost as much as robots, and takes much more labor.
Large Dairies are Adopting Now

- ± 60 robotic milking herds with more than 500 cows milked with single box robots
- ± 20 robotic rotaries

**BENEFITS:**
- lower labor cost
- fewer employees to manage and less repetitive work
- Less stress on cows with no trips to the parlor
- Potential for higher production through individual “dynamic” management
Social Licence

- Less stress on cows with no group movement and crowding
- Cows have more time to eat and rest
- Cows choose when to be milked (appeals to consumers)
Changes in Management
What is different: Less labor

29% less labor on Dutch farms with robots (Bijl, 2007)

- Fewer more highly skilled employees.
- Develop routines and protocols and design gating and handling systems for one person working alone.
Milking is voluntary and milking intervals vary.

- With 4 hr. permission vs 8 hr., cows milked 3.2 vs 2.1 times/day and produced 9% more milk (Melin 2005)

- How do we avoid long interval “fetch” cows?

Figure 2. Frequency distribution of milking intervals in hours over a 2-year period (De Koning & Ouweltjes, 2000)
Estimated Production Response to Irregular Robotic Milking compared to 2x...12/12

<table>
<thead>
<tr>
<th>Cow</th>
<th>Milking intervals</th>
<th>Milkings per day</th>
<th>Production vs 2x</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5-6-6-7</td>
<td>4</td>
<td>+18%</td>
</tr>
<tr>
<td>B</td>
<td>12-7-5</td>
<td>3</td>
<td>+ 6%</td>
</tr>
<tr>
<td>C</td>
<td>15 - 9</td>
<td>2</td>
<td>- 2 %</td>
</tr>
<tr>
<td>D</td>
<td>15 - 15</td>
<td>1.6</td>
<td>- 6%</td>
</tr>
<tr>
<td>Ave</td>
<td>9.3 hrs</td>
<td>2.65</td>
<td>+ 4%</td>
</tr>
</tbody>
</table>

It will take an average of 2.4 milkings/day to match 2x, and 3.2 milkings/day to match 3x parlour milking.
Capital investment in the milking system is higher... So demand high output per robot

Standard – 4500 lbs./single box/day
from 60 cows @ 75 lbs./cow

- 29 farms in Spain (Castro, 2012) 3225 lbs./day
  from 52.7 cows @ 62 lbs./cow
Could be optimized with 16 more cows and 33% more milk

- JTP Farms in Wisconsin 5900 lbs/day
  from 62 cows @ 95 lbs/cow
Optimize Robot Efficiency

- Keep the box occupied with high milk flow rate cows
- Variables include number of cows, milking speed, milk yield, milking frequency, milking permission interval, prep time, attachment time and success, refusals, entry and exit times and cleaning time. (Castro, 2012)

- Optimize by milking fresh cows and high producers frequently and low producers less often, minimizing failures (clean udders free of hair), culling slow milkers.

- “dynamic milking ” to capitalize on individual variation

- Higher stocking rates increase the number of “fetch cows” and increase labor. Aim for 10% free time
Robot Efficiency and Stocking Rate

- In 13 herds with 34 to 71 cows/robot (Deming 2013), higher stocking densities were associated with lower milking frequency.

- With more than 60 cows per robot, the number of fetched cows increases. (Rodenburg and Wheeler, 2002)
Do we need a different cow??

Higher milking speed increases AMS capacity. Reduce machine on time by 1 min/cow and increase capacity by + 12%. Select for milking speed.

-Poor udder conformation increases attachment failures which then become fetch cows. (Jacobs and Siegfried, 2012).

Select for good udders but also wide rear teat placement.

Canadian AI studs offer “Robot Ready indexes based on these traits that have no real basis in science. The Dutch prove bulls for “daughter box time”.

But we need to do better, and we can!!
Breeding Strategies for Robotic Milking

The heritability of voluntary milking frequency is 0.16 to 0.22 depending on stage of lactation. (Konig, 2006)

The records are there, both as robot generated data and as milking intervals for milk recording samples from robotic herds.

We need to prove AI sires for their daughters “interval from milking permission to milking” as well as box time.
Success Factors: The Ration

- Hard pellets with no fines increase milkings \(\text{(Rodenburg 2004)}\)

- Pellets made from barley and oats increased daily milkings per cow 0.35 vs a corn based standard, while high fat pellets decreased visits 0.36 and grass pellets decreased visits 0.93. \(\text{(Madsen 2010)}\)

- High grain, high starch diets decrease milking frequency \(\text{(Rodenburg and Wheeler 2002)}\)

- PMR formulated for 15 lbs. milk below the group average plus 4 to 18 lbs. of pellets according to production in the robot
Success Factors: The Ration

- Using guided traffic allows greater use of home grown grain in a PMR balanced for a higher production level, and less purchased pellets in the robot.

- Feeding “according to production” in the robot improves feed efficiency and negates the gains from using cheaper home grown grain.

- The net difference is very small.
Fetch Cows represent new labor

Number of Cows that Require Fetching

- Canadian owners reported fetching 4 to 25% of cows . . . large variation between herds (Rodenburg and House 2007)

- 35 free traffic herds fetched $16.2 \pm 10.8\%$ vs $8.52 \pm 5.9\%$ in the 8 guided traffic herds.

- Fetching 2 to 3% takes minimal effort . . . . ‘but more than 6 or 8% adds labor and is disruptive to the rest of the herd.
Guided Cow Traffic: Cows can only access feed after passing through the robot.

Feed in the bunk and robot both attract cows.
Guided Traffic (with Pre-selection): Eligible cows directed to robot and others to bunk

Feed First Guided Traffic

Selection gate

Feed Alley

Robot

Smart gate

Smart gate
**Free vs Guided Traffic**  
*(Thune 2002)*

<table>
<thead>
<tr>
<th></th>
<th>free</th>
<th>guided</th>
<th>pre-selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. milkings</td>
<td>2.0</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td>no. of meals</td>
<td>12.1</td>
<td>3.9</td>
<td>6.5</td>
</tr>
<tr>
<td>average time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>waiting at robot (minutes/day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant Cows</td>
<td>78</td>
<td>140</td>
<td>124</td>
</tr>
<tr>
<td>Timid Cows</td>
<td>95</td>
<td>240</td>
<td>168</td>
</tr>
</tbody>
</table>
### Free vs Guided Traffic (DeLaval VMS)
*(Bach 2009)*

<table>
<thead>
<tr>
<th>/cow/day</th>
<th>Free traffic</th>
<th>Guided Traffic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milkings</td>
<td>2.2</td>
<td>2.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fetched milkings</td>
<td>0.5</td>
<td>0.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PMR intake</td>
<td>41.0 lbs.</td>
<td>38.8 lbs.</td>
<td>0.24</td>
</tr>
<tr>
<td>Manger visits</td>
<td>10.1</td>
<td>6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Milk production</td>
<td>65.7 lbs.</td>
<td>68.1 lbs.</td>
<td>0.32</td>
</tr>
<tr>
<td>Fat %</td>
<td>3.65</td>
<td>3.44</td>
<td>0.06</td>
</tr>
<tr>
<td>Protein %</td>
<td>3.38</td>
<td>3.31</td>
<td>0.05</td>
</tr>
<tr>
<td>Fat yield</td>
<td>2.40 lbs.</td>
<td>2.34 lbs.</td>
<td></td>
</tr>
<tr>
<td>Protein yield</td>
<td>2.23 lbs.</td>
<td>2.25 lbs.</td>
<td></td>
</tr>
</tbody>
</table>
Free or Guided Traffic

- With Lely robots, free traffic yielded more milk per cow (2.4 lbs.) and per robot (148 lbs.) than guided traffic.  
  (Tremblay et. al. 2016)

- Some new fetch cows are emerging cases of lameness or clinical mastitis, so fetching has a role in monitoring herd health
Both can work very well with good management.

- But when things go a little wrong:
  - Guided traffic COWS suffer fewer meals and longer waiting times (and foot health and rumen health issues)
  - Free traffic FARMERS suffer increased fetching. (A warning to step up management)

- I design for both but for me cow comfort is key, so I have a strong preference for free traffic!
Robotic Milking calls for New Approaches to Barn Design

The classic US renovation layout for robots is a poor choice. The commitment pen on the left adds stress, and the free flow system on the right has no sort capability.
120 Comfortable Freestalls for Milking Cows

- 30 freestalls with flexible gating for far off dry cows or separation cows
- Bedding pack for fresh and lame cows
- Maternity pens
- Heifers
- Close ups

Perimeter feeding

Robot 1

Management rail

↑Chute (s)

↓Fetch pen 1

Robot 2

Bedding pack for fresh and lame cows

↓Fetch pen 2

Office

↑Tank

Utility

10 design criteria for success
Space is critical . . . Timid cows are afraid to come near this robot because they cannot get away
1. Large open area in front of the milking stalls
- 20 feet from the milking box to the first freestall
- Locate cow brushes, pasture selection gates, and computer feeders far away from this area to spread out barn activity
Wide finger gates reduce congestion in guided traffic barns
Robot Orientation
3 months of data from 12 herds
1165 cows (Gerlauf 2009)

38.7 % Cross Use
19.7 % selective use

% of cows in this robot use group

% of total milking visits to robot 1
Robots facing the same way result in the least selective use

Cows turn the same way to enter
Good visibility from the resting area

Cross use was high at 48.6 %
(vs 38.7% in all herds)

Selective use was lowest at 8.1 %
(vs 19.7 % in all herds)
2. All robots face the same way
New labor demands with robotics

• Fetching cows that don’t attend voluntarily
  - Provide simple cow routing and low stress fetch pens to get these cows milked

• Individual milking times are unpredictable
  - Provide a post milking separation area with access to feed, water, resting place and robot access.
3. Simple routing that makes all handling a one man job
   a. for fetching
   - Robot 1
   - Fetch pen 1
   - Robot 2
   - Fetch pen 2
b. Simple routing from group to group

- Milking
- Dry
- Fresh and Lame
- Calving
- Close Up
c. Simple routing to the handling area

One man, working alone, should be able to move any cow from anywhere to anywhere in the barn in one minute or less!
Handle individual cows in the chute
4. Handling fetch cows should be low stress and promote learning with split entry fetch pens
Split Entry Fetch Pen for Fetched Cows Only
Progressive Teaching of voluntary milking
1- push cow in
2- chain the gate and leave her
3- leave her in the fetch pen
4- release her to the herd
5. Maximum comfort for fresh and lame cows in a bedding pack with robot access
6. A stress free calving line with close up, calving and fresh cows side by side in bedding packs
Lameness decreases Robot visits and increases fetch rates (Bach 2007) (Borderas 2008).

- Lameness is multi-factorial:
  - Nutrition
  - Cleanliness of the Barn
  - Genetics
  - Cow Comfort/Resting Time
  - Foot Bathing
  - Trimming and Treatment
Healthy claws: 4 success factors

1. Good claw quality
2. Low infection
3. Low pressure
4. Early, effective treatment
Footbath at the robot exit discourages visits
Number of passes is highly variable
A footbath in a remote crossover

- All cows get equal passes
- Fresh chemical works better
- Keeps chemical away from milk and delicate metal parts
- Disrupts cows and adds labour
- Combine with scraping and bedding
7. Strategic Footbathing in a separation lane
New labor demands with robotics

- There is no fixed milking time so cow handling gets more complicated
8. Flexible separation area (a) gated for 2 stalls

Far off dry cows
8. Flexible separation area (b) gated for 16 stalls, including 14 borrowed from far off dry cows.
Far off dry cows
Big herds that handle daily need less separation space.
Cows never leave the barn.....

....Big equipment is disruptive!

Don’t tractor scrape
Automate bedding delivery, or straight wide,
drive through alleys, big crossovers and free traffic minimize disruption of the cows.
10. Open alleys through the full length of the barn
The ten barn design criteria for robotic milking

1. Open space near the robots
2. All robots the same way
3. Simple routing to robot, group to group and handling area
4. Split entry fetch pen
5. Fresh and lame pack with robot access
6. Stress free calving line
7. Flexible grouping
8. Flexible separation area
9. Perimeter feeding
10. Straight lines for material handling

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Links to:
World Dairy Expo lecture
Hoard’s Webinar
Expandable – 4 robots ± 250 cows
Expandable
8 robots ± 500 cows
1000 cows milking in 8 groups of 120 cows plus a fresh cow robot with 40 cows
The Future?

- Large herd applications
- Optimize robot efficiency
- Breeding the ideal robotic milking cow
- Optimize barn design (cow behaviour and comfort)
- Nutrition, Health and Economics
Thank You!

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