Combining Automatic Milking and Precision Grazing

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Teagasc, Ireland; Wageningen UR Livestock Research, The Netherlands; Danish Agricultural and Food Council, Denmark; Swedish University of Agricultural Sciences, Sweden; Institut de l’Elevage, France; University of Liege, Belgium
Outline of presentation

- Progression in automatic milking
- AUTOGRASSMILK project
- A snapshot of results mid way though the project
- Focus on the Irish perspective
- Results from 2 recent trials
- Current research
- Grazing management
- Economic aspect
- Concluding remarks
What is an automatic milking system?

- The AM system can perform the tasks of:
  - cow identification,
  - supplementary feeding,
  - teat washing,
  - teat location,
  - milking cup attachment,
  - milking and cup removal
- all without human intervention
### 1st AMS Units

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>1985</td>
<td>First milking cup attached to a cow using a robotic arm in exp. setting</td>
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<tr>
<td>1992</td>
<td>First commercial AMS installed on a farm in The Netherlands</td>
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</table>

- **One of the first successful attempts in attaching a teat cup to an udder with robotic arm, Silsoe Research, UK.** *(Picture: EJ Hillerton)* Source: www.dairynz.co.nz

- **Lely Press Release 15th Aug 2012:**
  - more than 15,000 Lely Astronaut Robots sold

- **DeLaval Press Release 10th Sept 2013:**
  - 10,000 Voluntary Milking Systems sold

**Current estimate 2015:**
- Up to 30,000
Further development in early 2000s
Integrating automatic milking systems with grazing

Australia:
http://www.dairynz.co.nz/page/pageid/2145870032/Latest_Research_and_Development

New Zealand:
http://www.dairynz.co.nz/page/pageid/2145869624/Automated_Milking_Systems_AMS_

USA:
http://pasturedairy.kbs.msu.edu/robotic_milking/
Research integrating automatic milking with grazing using different systems

Mobile AMS at University of Liege, Belgium

Mobile AMS at Institut de l’Elevage, Trévarez, France

Rotary automatic system Swedish University of Agricultural Sciences, Sweden

The Irish Agriculture and Food Development Authority
**Situation:**
Automatic milking (AM) and grazing in EU & Ireland

- AM is increasing in most EU countries
- But here - AM usage is associated with a decrease in grazing
- There is also increasing interest in AM in Ireland
- But in Ireland the majority of milk production is from spring calving herds on a seasonal grass based system
- Challenges:
  - (i) increase pasture grazing in conjunction with AM in EU countries with traditional indoor systems
  - (ii) if AM to be introduced in Ireland - have to be integrated with an intensive grazing based system so that the established economic benefits of grazing will be maintained

The Irish Agriculture and Food Development Authority
Grazing management in context

- A strong relationship between costs of production and proportion of grass in the cow’s diet
- French et al. (2015) profit per hectare is increased by €267 for each additional tonne of grass utilized within dairy systems
- Dutch study: zero grazing farms earned ~€0.5 to 2.0 /100 kg milk less than farms using full or time limited grazing (Van den Pol-van Dasselaar et al., 2008)
- Competitive advantage of grazed grass expected to increase:
  - anticipated higher concentrate prices
  - conserved feed costs expected to continue to increase - contractor charges also –inflation in labour costs, energy and machinery costs.
- BUT the higher the proportion of grass in the cows diet – the more important is accurate measurement of pasture – it is critical for effective grazing management
Representatives from 6 countries developed a proposal for FP7 funding. 14 partners – 6 research performers, 6 SME-associations and 2 end-user farmers.

<table>
<thead>
<tr>
<th>RTD</th>
<th>SME-AG</th>
<th>Country</th>
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<tbody>
<tr>
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<td>IGA</td>
<td>Ireland</td>
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<tr>
<td>IDELE</td>
<td>CNIEL</td>
<td>France</td>
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<tr>
<td>WLR</td>
<td>LTO</td>
<td>The Netherlands</td>
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<td>SLU</td>
<td>SDA</td>
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<td>CDL</td>
<td>Belgium</td>
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<tr>
<td>AU</td>
<td>VFL</td>
<td>Denmark</td>
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<tr>
<td>SME Farm IE - Ireland</td>
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<tr>
<td>SME Farm - Denmark</td>
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</table>
Planned deliverables of project

- Protocols for optimum feeding strategy for dairy cows incorporating grazing with AM technology for the various countries as influenced by grass supply and quality, farm infrastructure and cow type
- Pasture management tools that will facilitate AM dairy farmers to implement excellent grazing management practices
- A sustainability assessment tool for farmers to evaluate their own AM/cow grazing system
- Web based decision support tool that will facilitate dairy farmers to optimise economic efficiency when combining grazing with AM technology
- Guidelines for optimized operation of both mobile and carousel AM units in grazing scenarios
Summary of findings at mid term review

- In Ireland (2013) a 70 cow herd was milked in an AM system with grass contributing 85% of cow diet. The average milk yield was 4,222 L and milk solids yield was 369 kg.

- Swedish study (2013) found no difference in milk production of high yielding cows on diets of 8% and 27% grazed grass.

- French study showed grazing can be combined with AM and, although milk yield was reduced, feed cost was lowered substantially (by 66% per 1,000 L milk).

- Belgian study demonstrated that supplementation with concentrates during pasture shortage increased milk yield, but the economic cost has to be examined.
Moorepark

- Climate: mild, temperate; Rainfall: ~1500mm
- Excellent grass growth; 10 tonne DM/ha/year
- Growth season–280d; Dairying profitable enterprise
- 18,000 farms; 1.2m cows; 90% dairy products export
Research perspectives in relation to grazing

- in most EU countries – include some grazed grass in cow diet if possible on automatic milking farms
- in Irish scenario - integrate automatic milking into a grass based system of milk production

Practical challenges of integrating AM and grazing

- Seasonal limitation - peak milk yields
- Correct grass allocation critical for optimal cow visits to the AM unit
- Time spent waiting to be milked
- Achieving high utilization of the AM unit to minimize capital costs

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ABC grazing system to aid movement of cows to the milking unit

Section A
00:00 to 08:00

Section B
08:00 to 16:00

AMS

Section C
16:00 to 00:00

3-Way Grazing (ABC) System

A + B + C = 8hrs + 8hrs + 8hrs = 24hrs

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At pre-selection gate 1: Cows due for milking go to robot

Cows destined for C go out to C

Separate entry points for A, B and C blocks
Cows recognised at two selection gates (1 and 2).

Cows destined for A or B go through bypass to selection gate 2
Specifically in Ireland

Milking frequency (MF) is likely to be less than in indoor systems and quality and quantity of grass deteriorates in autumn (late lactation)

Report on 2 specific studies

- Examine effect of reduced MF on milk production and cow traffic in mid lactation
- Examine effect of different MF and concentrate supplementation levels on milk production and cow traffic in late lactation
Milking frequency trial in mid lactation (May to Aug 2014)

Materials and methods:

- 12/05/2014 to 03/08/2014 (Trial period = 12 weeks)
- 64 cows in two groups, each group balanced for: breed, lactation, days in milk, previous 20 days milk production and milking frequency
- Treatment: Milking Permission 2 & 3 times /d (adjustment period =10d)
- Measurements:
  - Milk Characteristics: Milk Yield
  - Cow Traffic: Milking Frequency, Wait Time, Box Time
## Results

<table>
<thead>
<tr>
<th></th>
<th>MP 2</th>
<th>MP 3</th>
<th>Difference</th>
<th>p value</th>
<th>p value note</th>
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<tr>
<td>Milking Frequency/day</td>
<td>1.5</td>
<td>1.8</td>
<td>0.3</td>
<td>&lt;.0001</td>
<td>Different</td>
</tr>
<tr>
<td>Milking Interval/visit (h)</td>
<td>15.1</td>
<td>12.6</td>
<td>2.5</td>
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<tr>
<td>Milk Yield/visit (kg)</td>
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<tr>
<td>Milk Yield/day (kg/cow)</td>
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<td>19.0</td>
<td>0.6</td>
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<tr>
<td>Milk Duration/day (min)</td>
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<td>12.3</td>
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<td>Wait Time/day (h)</td>
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<td>2.5</td>
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<td>0.0007</td>
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</tr>
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</table>
Effect of milking frequency

- Concentrate consumed at AMS kg/cow/day = 0.7
- Total grass DM kg/cow/day = 17.3

Not Different

Not Different
Conclusions

Cows milking 1.8 and 1.5 times per day produced 19.0 and 18.4 kg of milk/cow/day, respectively
Not significantly different
Potential to reduce milking frequency without adverse production effects
Reduced MF reduced waiting time – potentially good – less time standing on concrete
Reduced MF reduced milking duration /day and increased AMS free time and therefore would permit more cows to be milked throughout the day – potential for larger herd size
Milking frequency and supplementation trial in late lactation (Aug to Nov 2014)

Materials and methods:

- 18/08/2014 to 02/11/2014 (11 weeks)
- 64 cows in four groups, each group was balanced for: breed, lactation, days in milk, previous 14 days milk production and milking frequency
- Treatment: Milking Permission 2 & 3 times/d (adjustment period = 14d) and supplementation at 0.8 and 3.0 kg
- Measurements: Milk Characteristics: Milk Yield, composition, SCC, TBC; Cow Traffic: Milking Frequency, Wait Time, Box Time; Grass measurements: grass cover, allocation, height
Analysis – Milking frequency

- Kg 3 MP 1.9
- Kg 0.8 MP 1.9
- Kg 3 MP 1.3
- Kg 0.8 MP 1.3
## Results – Milking permission

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<tr>
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<td><em>p value</em></td>
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<td>Milk Yield/visit (kg/cow)</td>
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<td>Milking Interval/visit (h)</td>
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<td>Milk Duration/day (min)</td>
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<td>Different</td>
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<td>Wait Time/day (h)</td>
<td>2.1</td>
<td>1.6</td>
<td>0.003</td>
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Analysis - Concentrate

<table>
<thead>
<tr>
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## Results - concentrate

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<th>Concentrate/Day (kg)</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Milk Yield/day (kg/cow)</strong></td>
<td>16.3</td>
</tr>
<tr>
<td><strong>Milk Yield/visit (kg/cow)</strong></td>
<td>10.0</td>
</tr>
<tr>
<td><strong>Milking Interval/visit (h)</strong></td>
<td>13.6</td>
</tr>
<tr>
<td><strong>Milk Duration/day (min)</strong></td>
<td>9.9</td>
</tr>
<tr>
<td><strong>Wait Time/day (h)</strong></td>
<td>1.7</td>
</tr>
</tbody>
</table>
Conclusions

- Reducing MF in late lactation
  - reduced milk yield
  - increased milking interval (>16h)
  - reduced milking duration and waiting time
- A milk yield response to concentrate supplementation was obtained
2015 - Optimum cow breed/type for an integrated grazing and AM milk production system

Study 1 – Spring Supplementation
• Treatment: high and low concentrate

Study 2 – Breed Comparison
• HOxFR v JExHO v NR

Study 3 – Autumn supplementation
• Treatment: high and low concentrate
• Grass is the main component of the diet
• Grassland management is vital

Need to:
• Grow large quantities of grass
• Utilise as grazed grass
• Long grazing season

• Optimise milking frequency
  • Milk 80 cows per robot
  • Milking frequency 1.5 times/day

Only 300 - 400 kg/cow/lactation
Challenge of grass and grazing management on farms where automatic milking is integrated with grazing
Pre grazing herbage mass
1300 - 1500 kg DM/ha

Post grazing sward height
4.0 - 4.5 cm
Monitor Farm Study

Conducting data collection on farms over 2 year period (2014, 2015)

Environmental data
- Electricity and water - total energy of milking process and cooling, water usage recorded
- Nutrient use and farm inputs – fertiliser used, silage made, manure management, contract use, farm fuel

Labour data collected monthly

Economic data  Production data (milk yield, composition, SCC)
Economics

• Comparison of conventional and AMS systems
  • Interaction between capital investment, labour requirement and running costs
  • Financial metrics: profitability and return on investment.

• Optimizing the system
  • Focus on output of the system rather than output per cow
  • Reducing MF and increasing cow number versus higher number of high yielding cows

• Additional Scenarios
  • External land block – Fragmentation
  • Alternative enterprise, beef or tillage
  • Working off-farm
Concluding: Where do we go from here

- Can reduce milking frequency without reduction in milk yield
- But limit
- Could have larger herd size
- Focus on maximizing output from system rather than cow
- Look at MS – best breed
- Focus on maximizing cow number by reducing milking frequency during peak – this is the limiting time – but could have carry over effect
- Focus on grazing management – AB versus ABC grazing
- Altering grass availability and gate time changes to maximize milkings
- AM is being discussed and considered increasingly in Ireland