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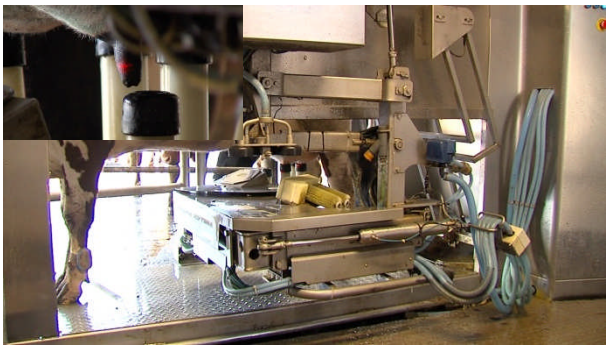
# Automating the Milking Process within a Grass-based System



## Key external stakeholders:

Farmers, Advisory personnel, Milking machine companies

## Practical implications for stakeholders:

- Automatic milking systems (AMS)s can be operated successfully within a grass based milk production system and milk yields comparable to many commercial batch milking systems can be achieved when grazing management is managed in order to control cow traffic
- The fact that milk yield/cow/day was not significantly affected by reducing milking frequency from 1.8 to 1.4 times/day in mid lactation means that a larger cow herd size could potentially be associated with an automatic milking unit. Consequently a higher total milk output per unit could be achieved thus increasing profitability
- Concentrate supplementation in the latter stages of lactation resulted in increased milk yield and more frequent cow visits
- Such a scientific appraisal of an AMS provides information necessary for future decision making on the direction of milking organization on dairy farms in Ireland

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## Main results:

- When a 70 cow herd were milked by an automatic milking system (AMS) within a grass based production system, an average milk yield of 4,222L and milk solids yield of 369kg per cow was achieved during the complete lactation. The average number of milkings per day was 104, ranging from 70 to 123 per day in the March-to-August period. The average number of milkings/cow per day was 1.8, ranging from 1.6 to 2.1. An average milk somatic cell count of 152,000cells/mL was observed, while average total bacterial counts were at 10,000cells/mL in the same time frame.

- Milk yield/cow/day was not significantly affected by milking frequency of 1.4 (18.4 kg/cow/day) or 1.8 (18.6 kg/cow/day) in mid lactation.

- Cows on a lower concentrate level compared to cows on a higher concentrate level had a significantly lower milking frequency, longer milking interval per visit, lower milk yield per day ($p$ <0.0001) [14.4 versus 16.2 kg/cow/day] and a shorter milking duration per day in late lactation.

## Opportunity / Benefit:

The successful integration of an AMS unit into a grass-based milk production system in Ireland has potential to affect labour demand (reduce), labour efficiency (increase cow numbers per operator), cost of labour (reduce) and availability of labour (low level of physical work). Furthermore, the generation of considerable milking and individual cow data would allow much greater control by the manager over the system

## Collaborating Institutions:

DairyNZ, Hamilton, New Zealand.



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**External collaborators:** Dr. Jenny Jago (DairyNZ, New Zealand)

## 1. Project background:

Dairy farming in Europe has adopted automatic milking (AM) at an accelerating rate, particularly in Western Europe. The main reasons for this are improvement in lifestyle, reducing physical work, difficulty in attracting skilled labour, increased profitability based on higher milk production (within high input systems) and lower labour costs. This trend is increasing and it is envisaged that up to 20% of cows in Europe will be milked automatically by 2020. However, while indoor feeding systems have been well adapted to AM, cow grazing systems have not. In order for AM to become a realistic alternative to conventional manual milking in Irish grass-based systems, the practical challenges of integrating AM and grazing must be researched. AM has the potential for advancement in precision dairy farming, e.g., to improve automatic data collection, providing herd managers with data that will enable them to make effective management decisions, and focus on strategic tasks that are economically beneficial.

## 2. Questions addressed by the project:

- To investigate the operational details and milk output of an AMS in an Irish grass based system
- To investigate the effect of milking frequency on milk production characteristics and cow traffic in mid lactation
- To determine the effect of concentrate supplementation and milking frequency on milk production and cow traffic in an AMS in late lactation in a grass based production system

## 3. The experimental studies:

**Automatic milking in a grass based production system**

*Farm system description:* A milk production system trial was put in place. The dairy featured one Merlin 225 AM unit (supplied by Fullwood for research) installed adjacent to an existing shed. The farm-let associated with the AM system consisted of a 24ha milking platform. The system had 70 spring-calved cows of Friesian, Jersey-Friesian cross and Norwegian Red breeds. The land area was divided into three grazing sections of 8ha each (A, B, C), which were further divided into 1ha paddocks. Four main roadways radiated from the centrally located dairy. Water was located at the dairy. The maximum distance to the furthest paddock was approximately 750m. The infrastructure incorporated a pre-milking waiting and post-milking area. There were three drafting units, two positioned at the entrance to the dairy that drafted cows to the pre- or post-milking area depending on readiness for milking, and a third positioned at the dairy exit, which drafted cows to a holding yard or to grazing.

*Grazing management:* The grass allocation was critical to optimal cow visits to the AM unit (it could influence too frequent or infrequent cow visits). Cows grazed defined areas or portions of each of the three grazing sections during each 24-hour period. Cows could be allocated, for example, 5kg DM in each of the three grazing sections (A, B and C) over each 24-hour period. Cows had access to fresh pasture at 00:00am, 08:00am and 16:00pm, in A, B and C, respectively. Cows moved voluntary between each of the 3 sections over the 24 hour period. During the May/June period cows went into grazing areas with grass covers of 1,400-1,500kg DM/ha. Grass covers greater than 1,500kg DM/ha would discourage cow movement to the AM unit and may reduce milking frequency. Cows grazed to a post-grazing height of 3.5-4.0cm. Cows were stocked at an average of 3.5 cows/ha. All cows received approximately 1kg concentrate/day during the main grazing season.

**Milking frequency in mid lactation**

In a grass-based system, it is important to focus on the total output of the AM system rather than the output per cow. Thus, a trial was designed to answer the research question: would fewer cows with a relatively high milking frequency and high milk yield, or a higher cow number accompanied by reduced milking frequency and lower per cow milk yield, result in more total milk output and potentially more profitable system. The farm system comprised of the milking platform and dairy containing the Fullwood AMS unit as above. The grazing management was as outlined above. Cows received a fresh allocation of grass in each grazing block each day. Allocations were of equal sizes in each block. A herd of 68 primiparous and multiparous cows of mixed breed (Holstein Friesian, Jersey, Jersey x Friesian and Norwegian Red) were randomly assigned into two groups that were balanced for breed, parity, days in milk; previous 25 days milk yield and milking frequency. Milking permission of 2 and 3 times per day were assigned to group 1 and 2, respectively. Cows adjusted to this treatment over a 10 day period, which was followed by a data collection period of 12 weeks between the 12th of May 2014 and 3rd of August 2014. During the experimental period cows were offered on average



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17.3 kg DM grass and 0.8 kg concentrate daily. Milk production and cow traffic data were obtained from the AMS unit. Cows were identified with a time stamp at three independent areas; a separation gate pre-milking, at the AMS unit itself and at a separation gate post milking. Cow traffic data were collected from each of these. Data were analysed using repeated measures analysis (PROC MIXED) in SAS. The fixed effects were week, breed, days in milk, previous yield per cow per day and milking permission, while the random effects included cow traffic (including milking frequency) and milk production.

**Concentrate supplementation and milking frequency in late lactation**

The farm system comprised of the milking platform and dairy containing the Fullwood AMS unit with grazing management as outlined above. Sixty five cows were randomly allotted to four groups and balanced for breed, lactation, days in milk, previous milk yield and milking frequency. There were 2 concentrate levels (3kg, 0.84kg) and 2 milking permissions (3.2, 1.8 times per day). During 11 weeks (18/08/14 to 02/11/14) the groups consisted of high concentrate with high milking permission (HCHP) and low milking permission (HCLP) and low concentrate with high milking permission (LCHP) and low milking permission (LCLP). The statistical model used was a repeated measure ANOVA in SAS (PROC MIXED) and Tukey's post-hoc analysis. The fixed effects were week, breed, days in milk, previous yield per cow per day and milking permission, while the random effects included cow traffic and milk production.

## 4. Main results:

**Automatic milking in a grass based production system**

An average milk yield of 4,222 litres and a milk solids yield of 369 kg per cow were achieved during the 2013 lactation, which is comparable to production obtained on a large proportion of Irish dairy farms. Average number of milkings per day was 104, (range 66-128) per day between March and August. Average number of daily milkings per cow was 1.8, (range 1.6-2.1). An average milk somatic cell count of 152,000 cells/ml was observed, with an average total bacterial count of 10,000 cells/ml. These findings demonstrate that AM can be integrated into milk production systems where grass forms 85% of the cow diet, and that with proper management routines, it should be possible (using AM systems) to achieve milk production levels and animal well-being that are at least as good as those achieved using conventional milking systems.

**Milking frequency**

By allowing milking permission of 2 and 3 times per day, milking frequencies of 1.4 and 1.8, were achieved for groups 1 and 2, respectively. This was due to the voluntary nature of the system, whereby cows must present themselves for milking. Milking interval is influenced by milking frequency, thus a significant difference in milking interval was also observed between group 1 (15:16:44) (h:min:sec) and group 2 (12:44:50). However, milk yield/cow/day was not significantly affected by milking frequency (Table 1). Although group 2 had permission to milk up to 3 times per day, this did not affect the return time of the cows to the AMS unit, per visit or per day. However, while waiting time/visit was similar for both groups, waiting time/day was significantly longer for cows with a milking frequency of 1.8. This reduced waiting time/day associated with the lower milking frequency would have positive implications for a herd as it would allow for additional time available for grazing.

Table 1. Mean milking frequency, milk yield and cow traffic performance for each group

| | Group 1 | St. Dev | Group 2 | St. Dev | P Value |
|---|---|---|---|---|---|
| Milking Frequency/Day | 1.4 | 0.014 | 1.8 | 0.017 | <0.0001 |
| Milk Yield/Visit (kg) | 12.8 | 1.21 | 10.3 | 1.00 | 0.1629 |
| Milk Yield/Day (kg) | 18.4 | 1.45 | 18.6 | 1.55 | 0.1694 |
| Milking Interval(h:min) | 15:16:44 | 2:09:19 | 12:44:50 | 1:25:30 | <0.0001 |
| Wait Time/Visit (h:min) | 01:27 | 00:25:43 | 01:18 | 00:23:19 | 0.3007 |
| Wait Time/Day (h:min) | 01:55 | 00:34:27 | 02:11 | 00:39:45 | 0.028 |

**Concentrate supplementation and milking frequency in late lactation**

For the dependent variables of milk production (milk yield per visit and per day) and cow traffic (milking frequency, milking interval per visit, milking duration per day and waiting time per visit) the interaction between milking permission and concentrate level was not significant. The effects of milking permission and concentrate level were significant for each dependent variable. Cows on the high and low milking permission had a milking frequency of 1.9 and 1.3 per day, respectively (Table 2). Cows on HC and LC had an allowance of 3 and 0.84 kg per day, respectively. Cows with lower milking permission (HCLP and LCLP) compared to cows with a higher milking permission (HCHP and LCHP) had a significantly longer milking interval per visit ($p$ <0.0001), lower milk yield per day ($p$ 0.002), shorter milking duration per day ($p$ <0.0001) and less time waiting to be milked per day ($p$=0.003). Cows with the lower concentrate level (LCHP and



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LCLP) compared to cows with the higher concentrate level (HCHP and HCLP) had a significantly lower milking frequency ($p$=0.022), longer milking interval per visit ($p$ <0.012), lower milk yield per day ($p$ <0.0001) and a shorter milking duration per day ($p$=0.001). Decreasing milking permission had a positive impact on cow traffic as cows spent significantly less time waiting to be milked. Concentrate supplementation level had no significant effect on waiting time per day.

Table 2. Effect of milking permission and concentrate supplementation on milk yield (MY), milking frequency (MF), milking interval (MI), milking duration (MD) and waiting time (WT).

| | Milking Permission/Day (Milking Frequency/Day) | | |
|---|---|---|---|
| | 1.8 (1.3) | 3.2 (1.9) | *p* value |
| MY/Day (kg) | 14.9 | 15.7 | 0.004 |
| MI/Visit (hrs) | 16.5 | 11.6 | <.0001 |
| MD/Day (mins) | 8.5 | 10.5 | <.0001 |
| WT/Day (hrs) | 1.6 | 2.1 | 0.009 |
| | Concentrate (kg) | | |
| | 0.84 | 3.00 | *p* value |
| MY/Day (kg) | 14.4 | 16.2 | <.0001 |
| MF/Day | 1.6 | 1.7 | 0.031 |
| MI/Visit (hrs) | 14.6 | 13.5 | 0.015 |
| MD/Day (mins) | 9.1 | 9.8 | 0.001 |
| WT/Day (hrs) | 2.0 | 1.7 | 0.085 |

## 5. Opportunity/Benefit:

From an EU perspective where AMS have been in operation with some time, the consideration is that automatic milking has a positive impact on both the work life and social life of the farmer and on the overall sustainability of the family farming system. Preliminary work has indicated that a similar effect would be observed in Ireland. The decision to invest in AM requires prior investigation into system management, procedures, performance, and other skill sets required (e.g., grassland management and interpretation of data output). Farmers need to be in a position to make well-informed decisions, understand the technology, and have realistic expectations of the technology. Irish research completed on automatic milking provides this. Integration of AM into pasture-based systems is challenging, but it has been achieved successfully. Thus, it is suggested that a potential role for AM exists within a grass based system of milk production. Furthermore, it may represent a solution to farm fragmentation.

## 6. Dissemination:

In addition to written publications (examples listed below), approximately 400 farming and research personnel have visited the automatic milking research farm between 2012 and 2014. Such information has also been made available to large audiences at open days and farmer discussion group meetings.

### Main publications:

O'Brien B., and J. Upton. 2013. Combining automatic milking and precision grazing on dairy systems. In: Precision Livestock Farming '13. Berckmans D. and J. Vandermeulen (eds). pp 217-222.

Foley C., Shortall J. and O'Brien B. 2015. Concentrate supplementation and milking frequency in automated milking with grazing. In: Grassland and forages in high output dairy farming systems. Grassland Science in Europe, 20: 410-412.

O'Brien, B., Foley, C., Shortall, J. and Shalloo, L. 2015. An economic appraisal of automatic and conventional milking within a grass based seasonal milk production system. In: Precision Livestock Farming '15. Guarino M. and Berckmans (eds). pp 21 – 29.

### Popular publications:

O'Brien, B., Foley, C. and Shortall, J. 2015. Robotic milking in pasture based systems. T-Research, 10 (2):18-19.

Foley C., Shortall J. and O'Brien B. 2015.Performance of milking robots on Irish dairy farms.'Irish dairying, Sustainable Expansion' Moorepark '15, Teagasc, Moorepark Open Day booklet.pp 104-105.

Shortall, J., Sleator, R., Foley, C. and O'Brien, B. 2015 Preliminary measures of labour input on farms with conventional and automatic milking systems. In: Proceedings of XXXVI CIOSTA CIGR V Conference 2015 in St Petersburg, Russia. pp 39-42.

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