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Innovative and sustainable systems combining automatic milking and precision grazing

Key external stakeholders:
Automatic milking (AM), dairy farming, integration with cow grazing.

Practical implications for stakeholders:

- The project allows an increased number of stakeholders with AM systems to consider cow grazing as a realistic opportunity.
- Guidelines have been developed for the successful operation of both automated carousel (rotary) and mobile milking systems. Such systems are particularly suited to farms with large herds and with fragmented land bases, respectively.
- The construction of a web-based sustainability tool, based on the findings of this project, can help farmers (with help from their advisors) to understand and increase the sustainability of their farms.
- The development of a further web-based decision support tool can assist farmers and advisors in north-western Europe in the decision-making process around grazing and AM systems from an economic perspective.
- A range of information relating to cow grazing and AM has been published (in the different national languages) on the website.

Main results:

- Various strategies have been developed to maximize milk output from integrated grazing and AM in a wide range of production conditions, from pasture-based extensive systems with low feed costs, to intensive systems with only small amounts of pasture in the diet, aimed at high milk yield per cow.
- Recommended feeding strategies for periods of grass inadequacy as well as performance of different cow breeds were established.
- A new automated grass measurement tool was used to ensure the precision required in grass allocation particularly important in integrated grazing and AM systems.

Opportunity / Benefit:

The results of this research have:

- The project has provided the farming communities with guidelines on how best to practically integrate grazing with AM.
- It has highlighted that the uptake of AM reduces the labour demand of the farmer. However, until the commencement of this project it was not known if this was also true when AM was integrated with grazing.
- The aesthetic qualities of the communities within which dairy farmers traditionally practise grazing are maintained when farmers can continue grazing with AM. The project has improved the perception of AM through emphasising the positive effects of integrating AM and grazing.
- The sustainability and economic decision support tools developed within the project have the potential to impact positively on farmers considering alternative management strategies.

Collaborating Institutions:

Irish Grassland Association, Institut de l'Elevage and Centre national interprofessionnel de l'economie laitiere (France), University of Liege and Comite du Lait (Belgium), Wageningen UR Livestock Research and Land- en Tuinbouw Organisatie Noord (the Netherlands), Aarhus University and SEGES (Denmark), Swedish University of Agricultural Sciences and The Swedish Dairy Association (Sweden).

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1. Project background:

Dairy farming has adopted AM at an accelerating rate in many EU countries for reasons such as improvement in lifestyle, less physical work, attracting skilled labour and lower labour costs. The defining feature of AM systems is that the cows come voluntary to the milking unit and milking is evenly distributed over a 24 hour period. Up to now, indoor feeding systems have been well adapted to AM, however grazing has not, thus leading to a decrease in grazing on farms with AM. Grazing has many advantages for economy, environment, animal welfare and product quality. With increased focus on sustainability it is essential that dairy systems with new precision grazing technologies are developed in which grazing and AM can be integrated.

This project was a unique cooperation of 6 small medium enterprise associations (SME-Ags) and 6 research groups, with one of each based in Ireland, Denmark, The Netherlands, France, Belgium, and Sweden, up to 30 monitor farms across those countries and two partner farms in Ireland and Denmark. The specific objectives of the project were addressed through 5 work-packages and included (1) developing feeding strategies for dairy cows incorporating grazing with AM; (2) using new precision grazing technologies to optimize the integration of grazing and AM; (3) increasing the sustainability of integrated grazing and AM technologies; (4) developing a tool that will allow dairy farmers to optimize economic efficiency when combining grazing with AM and (5) continuously disseminate new technology to end-users in a form that is easily accessible and locally adapted to improve farm efficiency.

2. Questions addressed by the project:

- What is the optimum proportion of grazed grass in a cow's diet for AM based production systems, and how does AM performance compare for different cow breeds.
- How can good pasture management be achieved when integrated with an AM system
- Can guidelines be put in place for the operation of alternative AM technologies
- How would an integrated AM and grazing system be assessed from a sustainability perspective
- How does an AM system compare with a conventional milking system from an economic perspective

3. The experimental studies:

Firstly, diets incorporating approximately 90% and 75% pasture were compared in Ireland, while diets of 25% and 10% pasture were compared in Sweden. A further task was focused on establishing optimum cow breed/type for an integrated grazing and AM production system. Secondly, an evaluation of cow activity and eating/grazing behaviour of cows on AM and grazing systems was conducted using different sensor technologies. Data was collected on four research and two private farms in the Netherlands, Belgium, Denmark and France over three consecutive years. The accessibility to the pastures ranged from 6 to 24 hours per day. Also, the operation of both carousel and mobile AM systems at SLU (Sweden) and on the Trévarez site (France) and the Sart Tilmant site (University of Liège, Belgium) were evaluated. Thirdly, sustainability indicators were evaluated and experts in different countries consulted to determine the indicators most effective in assessing the most important dimensions of sustainability, e.g. economics, environment, social, etc. Fourthly, a report was conducted on the financial impact of different levels of grazing in Denmark, the Netherlands and France, and an interactive web based decision support tool was developed that would provide farmers and advisors direct access to information that could be used around grazing and AM based decisions.

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4. Main results:

In the Irish study no significant difference in milk yield was observed when milking frequency was reduced from 1.8 to 1.3 milkings per day. Thus lower milking permissions combined with a higher number of animals in the system may be economically advantageous in production systems with large proportions of pasture in the diet. Higher concentrate supplementation in autumn time (3.0 versus <1.0 kg/cow per day) did increase milk yield and milk traffic parameters were also favourably affected by a higher level of supplementation that led to a significantly shorter milking interval (13.6 versus 14.6 hours/visit and 16.4 vs. 18.0 hours/visit in the experiment of 2014 and 2015, respectively). In Sweden a daytime grazing system with production pasture and a small grass-covered paddock available to the cows for exercise and recreation only, were compared. Results showed that it was possible to achieve either higher milk yield or considerably lower intake of supplementary silage on production pasture compared with exercise pasture. Further results indicated that Norwegian Red^{x} and Holstein Friesian cows were more efficient within the system than the Jersey^{x} cows when taking cow traffic-ability into consideration. Breed and concentrate had a significant effect on milking interval and feed intake. Concentrate level significantly affected milk yield per day, whereas breed did not. Cow eating time was recorded on three farms with two types of neck sensors. Grazing time was increased with increasing (estimated) grass intake. The total eating time was lower, if the proportion of grass in the diet was decreased. With 40%, 65% and 100% grass in the diet, cows needed almost 6 hours (Dutch farm), 7 hours (Danish farm) and 9 hours (French farm), respectively. It was concluded that the mobility of a robot is technically possible and adds value to pastures that are distant from the main farm. However, it is not easy to organize and requires very early phase planning by farmers. A sustainability assessment tool was developed in Autograssmilk, where a farmer can complete various Excel sheets and then will be presented with a sustainability report. Within this tool, a farmer can select the reference values of his or her country, and also compare it to other countries. This can contribute to the awareness of differences in dairy production systems in the involved countries. An interactive web based decision support tool allows more informed decisions to be taken by farmers and advisors. The tool informs on the decision-making process around grazing and AM systems from an economic perspective. It provides an overview of relevant topics, research results, practical experiences and links to relevant interactive internet tools and to further information to be found on the internet. The economic impact of grazing dairy cows on farms equipped with an AMS was also analysed using existing accounting data of commercial dairy farms in Denmark, France and the Netherlands. In the Netherlands there was an economic benefit to grazing, which declined with increasing farm size. In France, income tended to be higher on farms that practiced grazing, and in Denmark an economic difference could not be established.

5. Opportunity/Benefit:

- The results clearly demonstrated that AM can be integrated with varying levels of pasture and economic implications of different scenarios can now be established by interested farmers
- AUTOGRASSMILK has impacted on companies selling and distributing AM machines by increasing their focus on grazing management strategies for their clients
- The project measured time required to operate an integrated AM and pasture system, thus demonstrating the possibilities for improved lifestyle or income through off- farm work.
- Finally, the AUTOGRASSMILK project has provided the means to long term impacts such as increased productivity in AM herds with grazing and increased numbers of AM system herds considering grazing as a realistic opportunity.

6. Dissemination:

Main publications:

Shortall, J., Shalloo, L., Foley, C., Sleator, R.D. and O'Brien, B. (2016). Investment appraisal of automatic milking and conventional milking technologies in a pasture-based dairy system. *Journal of Dairy Science,* 99: 7700-7713.

O'Brien, B., van den Pol-van Dasselaar, A., Oudshoorn, F., Spörndly, E. Brocard, V. and Dufrasne, I. (2015). AUTOGRASSMILK-Combining automatic milking and precision grazing. In: Proceedings of European Association of Animal Production. Session 34. Page 329. Warsaw, Poland. 31st August-4 September, 2015.

Foley C., Shortall J. and O'Brien B. (2015). Milk production, cow traffic and milking duration at different milking frequencies in an automated milking system integrated with grazing. In: *Proceedings of Precision Livestock Farming* '15. Eds. M. Guarino and D. Berckmans. Milan, Italy. September, 2015. pp 40–47.

Popular publications:

O'Brien, B. (2015). Cream of the crop. International Innovation. Issue 189, Research Media. 66-68.

Shortall, J., Foley, C., Sleator, R. and O'Brien B. (2015). A comparison of the labour requirements on Irish

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dairy farms with automatic and conventional milking systems integrated with grazing. In: *Proceedings of Precision Livestock Farming* '15. Eds. M. Guarino and D. Berckmans. Held in Milan, Italy. September, 2015. pp 774-781.
Shortall J., O'Driscoll, K., Foley, C., Sleator, R and O'Brien, B. (2015). Effect of milking frequency on hoof health and locomotion scores of cows milked in a pasture based AMS. In: Proceedings of Eurropean Association of Animal Production. Warsaw, 31st aug to 4th sept EAAP 2015 Session 34. page 333.

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