Grazing and automation

Proceedings 4th Meeting EGF Working Group "Grazing" in Wageningen

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This report presents the main results of the fourth meeting of the EGF Working Group “Grazing” which was held in Wageningen, the Netherlands on 14 June 2015. The aim of this Working Group is to exchange knowledge on all aspects of grazing research and to provide a forum for networking. The theme of the meeting in Wageningen was “Grazing and automation”.

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Wageningen Livestock Research Report 1003

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Foreword

The fourth meeting of the Working Group “Grazing” of the European Grassland Federation (EGF) was held in Wageningen, the Netherlands in June 2015 prior to the 18th Symposium of the European Grassland Federation. Usually meetings of the Working Group “Grazing” only take place prior to General Meetings of EGF, but in 2015 an exception was made because i) the topic grazing is a matter of concern in the Netherlands and ii) 2015 was the last year of the Autograssmilk project, which provided the opportunity to share the results with the EGF grazing community. The FP7 project Autograssmilk focused on the combination of automatic milking and grazing. The theme of the meeting was in line with this: “Grazing and automation”. We worked with sub-themes that were introduced by plenary speakers followed by discussion sessions in small groups of around 10 persons. Short summaries of the presentations and the discussion sessions can be found in this report. It is available together with pdf’s of the presentations on the internet at www.europeangrassland.org/working-groups/grazing.

The coordination team of the Working Group (editors of this report) would like to thank all the participants and especially the speakers, the chairs and reporters of the discussion sessions for their active participation in the meeting and the lively discussions during and after the meeting. The objective of this Working Group, i.e. to exchange knowledge on all aspects of grazing and networking, has, again, been fully achieved.

On behalf of the coordination team of the EGF Working Group “Grazing”,
Dr. Agnes van den Pol-van Dasselaar, the Netherlands (Chair)

Summary

This report presents the main results of the fourth meeting of the EGF Working Group “Grazing” which was held in Wageningen, the Netherlands on 14 June 2015. The aim of this Working Group is to exchange knowledge on all aspects of grazing research and to provide a forum for networking.

The theme of the meeting in Wageningen was “Grazing and automation”. There were five sessions:

- Welcome session / introduction / state of the art of grazing in Europe
- Grazing and EIP-AGRI Focus Group Permanent Grassland
- Grazing and automatic milking
- Grazing and automation
- Closure

The participants shared many research results, ideas and thoughts on these topics, which are summarised in this report.

1 Introduction

When discussing 'Grazing and automation', one automatically thinks of the combination of grazing and automatic milking systems (AMS). But the topic includes more, i.e. all systems that automate certain tasks associated with grazing, e.g. virtual fencing, use of sensors and decision support tools.

Grazing is an important theme for the European Grassland Federation (EGF) as grazing is the predominant use of grasslands. The Working Group on "Grazing" ensures detailed knowledge exchange and discussion. The Group was established in Uppsala, Sweden at the General Meeting of the EGF in 2008. The aim of this Working Group is to exchange knowledge on all aspects of grazing and networking. The first meeting was held in Kiel, Germany in 2010 (Research methodology of grazing), the second in Lublin, Poland in 2012 (Innovations in grazing) and the third in Aberystwyth, UK in 2014 (The future of grazing). Proceedings of all meetings can be found at www.europeangrassland.org/working-groups/grazing.

The fourth meeting of the Working Group was held in Wageningen, the Netherlands in 2015, prior to the 18th Symposium of the European Grassland Federation. There were 59 participants from 16 European countries present. The majority of the participants were from research, but there were also other stakeholders present. The theme of the meeting was "Automation and grazing".

There were several sessions during the meeting. In the first session (welcome session/introduction) the scene was set and data on grazing in Europe in 2015 were provided. The second session focused on the EIP-AGRI Focus Group Permanent Grassland and provided some reflections of the role of grazing in this group. The third session was on the combination of grazing and automatic milking, while the fourth focussed on grazing and automation. The sessions on EIP-AGRI, automatic milking and automation consisted of plenary presentations followed by a short plenary discussion. Thereafter, the theme was thoroughly discussed in group discussions in groups of about ten persons each.

Both the plenary presentations and the group discussions are summarized in this report. The welcome and introductory session is described in this chapter. The state of the art of grazing in Europe is described in Chapter 2. Chapter 3 reports on grazing and EIP-AGRI Focus Group Permanent Grassland. Chapter 4 reports on grazing and automatic milking. Chapter 5 reports on grazing and automation, followed by some concluding remarks in Chapter 6. Both this report and pdf-files of the presentations of the meeting can be found at the EGF website under the pages of the Working Group “Grazing” (www.europeangrassland.org/working-groups/grazing). The program of the meeting can be found in Appendix 1 of this report.

Figure 1 *EGF Working Group “Grazing” in Wageningen in 2015.*

2 State of the art of grazing in Europe - 2015

Agnes van den Pol-van Dasselaar

Data on grazing in Europe are not easily available. Since the first meeting of the EGF Working Group "Grazing" in 2010, surveys have been conducted among members of this Working Group. Results have been variable and there is no complete overview, but at least these results provide an image of grazing in Europe. Sometimes statistical data are available, but usually the numbers are only an educated guess. Furthermore, the amount of grazing is not defined. It can range from full grazing to very limited grazing. These observations should be kept in mind when reading the figures on grazing below; the data presented are mainly educated guesses. Table 1 shows that, in general, percentages grazing are decreasing and with automated milking systems (AMS) percentages are lower than without AMS.

Table 1 *Grazing and AMS in Europe 2015: grazing dairy cows (% of total dairy cows per country), number of farms with automatic milking systems (AMS) (% of total number of farms), grazing dairy cows on AMS farms (% of total dairy cows on AMS farms); educated guesses of members of the EGF Working Group "Grazing"*

Country	% grazing	% AMS farms	% grazing AMS
Belgium	65-95	5	5-30
Denmark	25	25	n.a.*
France	>90	10	n.a.
Hungary	0	0	0
Ireland	98-99.9	1-2	98-99.5
Luxembourg	75	>20	43
Netherlands	70	20	40-60
Norway	90	30	80
Poland	20	0.1	0
Slovenia	30-40	n.a.	<5
Spain	30	2	n.a.
Sweden	100	25-35	100
Switzerland	96	n.a.	n.a.
UK	70-90	1-20	5-50

*n.a. = not available

Members of the EGF Working Group "Grazing" believed that AMS and grazing are compatible. However, some remarks were made. The combination is seen as more difficult than grazing in combination with a traditional milking system. If the herd size increases, it is even more difficult. It requires a smart design of the farm that is adapted to the behaviour of dairy cows. The main challenges for grazing in combination with AMS are cow traffic (get cows outside and get cows inside, create a flow of cows coming to the robot and going to the field), grass management and grass allocation, infrastructure (roadways and fencing must be excellent), and the need for a totally new mind set of the farmer.

Further automation can be useful for grazing according to the members of the EGF Working Group "Grazing"; however, the basics should be excellent first. Some ideas for further automation:

- Mobile fences guided by GPS; barriers and fences opening/closing to facilitate circulation within paddocks and batches
- Measurement of grass availability, daily grass growth, soil fertility status, grass intake (yield and quality) per individual cow using e.g. GPS drones, animal sensors, satellite
- Cow management, cow location in real time (GPS, satellite monitoring and tracking) (paddock/barn, how long waiting in the yard), cow activity (walk, graze, ruminate, etc.)
- Herbage allocation – virtual fencing

- Fetching cows
- Commercial mobile AMS
- Automatic trimming of pastures directly after the cows have grazed
- A model that helps the farmer taking decisions to match grass allowance and quality with needs of individual cows (decision to start grazing on a paddock/to move cows to another paddock), based on the actual situation in the field and anticipation of the weather for the next 4 weeks

Finally, some recent developments related to grazing were shared:

- Belgium: Grazing will most probably be accepted as a measure to reduce ammonia in farms that are situated close to a Natura 2000 region
- Ireland: Benchmarking on grazing dairy farms
- Ireland: Public perception important – taken for granted that Irish milk is produced from grass
- Luxembourg: Agro-environmental subsidy to grazing farms, technical and financial support to install cow tracks and selection gates to improve cow traffic
- The Netherlands: Ministry expressed ambition to go from the current 70% grazing dairy cows to 80% grazing dairy cows by 2020
- The Netherlands: legislation on land-based growth of dairy farms
- The Netherlands: digital recording of location of cows is explored (inside/outside)
- The Netherlands: farmers' groups for new grazers have been initiated
- The Netherlands: grazing premium increased from € 0.5 for each 100 kg milk produced in 2014 to € 1 for each 100 kg milk produced in 2015
- Poland: milk products from grazing dairy cows are labelled and sold on the market
- Spain: R&D projects about identification of specific biomarkers that allow authentication of milk from fresh grass feeding and/or pasture grazing
- Sweden: research project establishing and maintaining high-quality trampling-resistant swards
- Sweden: grazing calendar adapted to Swedish conditions
- Sweden: public discussion on the grazing law: both supporters and opponents

3 Grazing and EIP-AGRI Focus Group Permanent Grassland

3.1 The European Innovation Partnership “Agricultural Productivity and Sustainability” or EIP-AGRI and the Service Point

Remco Schreuder, EIP-AGRI, Brussels

The EIP-AGRI Service Point connects all actors within the network. Information on EIP-AGRI can be found at the EIP-AGRI website www.eip-agri.eu. Focus Groups and Operational Groups are important components of EIP-AGRI. The EIP-AGRI Focus Groups tackle agricultural challenges combining practice and science leading to exchange of practical knowledge, priorities for innovative actions, ideas for operational groups, research needs from practice and project proposals to test solutions. The Focus Group “Profitability of Permanent Grassland” addressed the following topics:

- Definition of a grassland typology in relation to biodiversity and productivity
- Achieving grassland production that matches animal needs
- Benchmarking grassland dry matter production and utilization at regional and national levels
- Sustainable grassland production by increased functional group diversification
- Increase resource efficiency
- Differentiation of grass based products for higher market value: linking quality traits and management practices
- Life cycle assessment: evaluation of the environmental impacts of grassland-based systems using Life Cycle Thinking

3.2 Report on mini-paper EIP-FG Permanent grassland “Increase quality – quantity Functional Group diversification”

Piotr Goliński

The topics of the Focus Group “Profitability of Permanent Grassland” were reported in mini-papers. The mini-paper on “Sustainable grassland production by increased functional group diversification” showed that increased functional group diversity of swards correlates with increased stability and productivity of grasslands. Increasing functional diversity decreases the risk of invasion by undesired species. Benefits concerning functional group diversity on grassland can be obtained by appropriate composition of grasses, legumes, some herbs and – in silvopastoral vegetation – trees. Multi-species swards resulted in potential higher spatial heterogeneity of biomass, sward quality and forage intake. Grass-legume mixtures enhance yield of total nitrogen and uptake from symbiotic N_2 fixation.
In productive grassland systems, the positive diversity effect could be obtained from a mixture of just a few species, well adapted to the environmental conditions; mixed pasture sward with legumes instead of monoculture of ryegrass increases both productivity per unit of hectare and extend the grazing season. In pastoral farming systems of the Mediterranean basin the maintenance of a high level of inter and intra-specific diversity is essential to achieve satisfactory and persistent swards.

3.3 Summaries discussion sessions

Discussion items
Five groups of about 10 persons discussed the following items:

- What do we expect from the EIP-AGRI?

- What does EIP-AGRI do in your country?
- How important is permanent grassland in your country? What are the roles of permanent grassland? What are corresponding key performance indicators?
- Why maintain permanent grassland? Why not?
- What is the effect of the end of the milk quota on permanent grassland?

What do we expect from the EIP-AGRI?

- We expect that EIP-AGRI is an important tool to share knowledge, problems and solutions. Furthermore, it could be a platform to discuss relevant issues.
- To get funding for work in project groups in which different actors co-operate (researchers, farmers, advisors, business) aiming to solve the problems in agricultural practice.
- Facilitate the continuation of relevant projects.
- Compilation of farmers and other stakeholder's views, needs, ideas, etc. to make them available for policy makers. As Pillar 2 money (CAP) is considered to be "the farmer's money", the initiative for activities in this respect should come FROM the stakeholders, rather than being developed from outside and then GIVEN TO them.
- Grazing is definitely a topic that could be covered by H2020 Operational Groups.

What does EIP-AGRI do in your country?

- Some countries are still in the process of collecting ideas for the work, while in others the organization of the work is being discussed, and in others the topics are already available. However, research funding is still a key topic as it is insufficient in many European countries. Researchers attending the workshop were worried about the lack of funding for their work.
- Many countries are just starting up with information.
- Ireland – funds are used as incentive for farmers to join five meetings or discussion groups/year; Denmark – a collaboration, with national Operational Groups working continuously discussing concrete questions; Sweden – funds for conferences/meetings are used, not just for scientists and researchers, but also stakeholders.

How important is permanent grassland in your country? What are the roles of permanent grassland? What are corresponding key performance indicators?

- In those countries that were represented at the workshop, permanent grasslands play a very important role for agriculture in terms of production. But they are also considered as being very important for other services (multifunctionality). Key performance indicators: the yield of high quality forage, biodiversity.
- In countries with high livestock densities and intensive farming, grassland resowing and grassland improvement are key issues. In countries where grass farming is less intensive, there is a tendency to utilize more 'old' permanent grasslands.
- Permanent grasslands are important because they provide feed to dairy and beef cattle, sheep and goats at low cost.

Why maintain permanent grassland? Why not?

- Permanent grasslands should be maintained because of their huge role in the multifunctionality of agricultural areas.
- An initial question was how to define permanent grassland. For example, in Sweden, permanent grassland is the natural vegetation of the dry steppe soils without any agricultural management, while in the Netherlands permanent grassland is grassland older than 5 years. This is also the EU definition.
- There was a lot of discussion about restrictions in grassland management that are likely to arise from new legislation. Farmers are worried that a minimum area per farm will have to be in permanent grassland and that sward renewal will be restricted and therefore they are planning to undertake any mechanical operations in the near future.
- It is important that European governments make a decision on the definition of permanent grassland and are clear about the impacts of new regulations on permanent grassland.

What is the effect of the end of the milk quota on permanent grassland?

- In many cases, the end of the milk quota and the expected lowering of the milk price can mean the end of farming and consequently the end of biodiverse grasslands.
- Due to the end of the milk quota system, the price of the permanent grasslands will go up, at least in some countries with intensive dairy production systems, and in particular in areas where milk production is grass based / from grazing systems.
- It seems like milk production (in Sweden for example) is moving out from the smaller fields inside the forestland to the better and bigger fields when milk prices drop.

4 Grazing and automatic milking

4.1 Autograssmilk

Frank Oudshoorn

The Autograssmilk project (FP7-SME-2012-314879) was undertaken from 2013 to 2015 and focussed on the combination of grazing and automatic milking (AM) in Ireland, France, the Netherlands, Belgium, Sweden and Denmark. Grazing is important as it offers a cheap source of fodder, is good for cow health and cow welfare, improves milk quality with fresh grass, contributes to the landscape and biodiversity, is what the consumer wants, and is what the farmer wants. Automatic milking is important as a technology that relieves the farmer of physical labour and increases milk production per full time labour unit; it is a technology that enhances a farmers social life (including family of farmers), facilitates milking frequency aligned with yield, captures a lot of data easily and enhances cow management.

Autograssmilk aimed:

- To develop optimum feeding strategies for dairy cows incorporating grazed grass and AM for various production systems in Europe;
- To optimise the integration of AM with cow grazing using new technologies;
- To increase the sustainability of integrated grazing and AM technologies;
- To develop tools that will allow dairy farmers to optimise economic efficiency when combining grazing with AM systems;
- To continuously disseminate new technology to end-users in a form that is easily accessible and locally adapted to improve farm efficiency.

4.2 High yielding herds, automatic milking and grazing - is it possible to combine?

Eva Spörndly

The problem with grazing is that pasture intake is lower compared with silage/concentrate intake and that there are variations in pasture quantity and quality. SLU carried out research with part-time grazing and automatic milking. Results of the first year showed higher milk yield and lower silage intake compared to full time indoors. Results of the second year showed no differences in milk yield and lower silage intake. Combining automatic milking and grazing for high yielding herds is possible. Some challenges remain: farmers need decision support systems, advanced prognosis for pasture growth, and advice on the amount and timing of supplementary silage and on part-time grazing.

4.3 Grazing management in an automatic milking system

John Shortall

An experiment with grazing and automatic milking was set up in Ireland with the objectives:

- 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^{-1})
- Grass as main component of the diet (only 300-400 kg concentrates cow/lactation)

To achieve this, grassland management is vital. A 3-way grazing (ABC) system was used. In spring 2014, grazing started in the first week of February. In summer, the aim for pre-grazing herbage mass was 1200 – 1500 kg DM ha^{-1} and post sward grazing height 4 – 4.5 cm. The grazing season finished in

2014 at the end of November. In total, cows were 283 days at grass. The average post grazing sward height was 4.93 cm and 14.8 tonnes DM ha^{-1} grass was grown. The concentrate supplementation fed was 365 kg cow^{-1}. Finally, milk yield was 4,400 L cow^{-1} and milk solids yield was 380 kg cow^{-1}.

4.4 Video Liège: transporting an AMS

The transfer of the automated milking system at the experimental farm of Liège University, Belgium, on Monday, April the 20th, 2015 can be seen in the following video: http://www.fmv-multimedia.ulg.ac.be/videos/transfer-automated-milking-system.php.

4.5 Monitor farm benchmarking for integrating an AMS and grazing in a spring calving herd in Ireland

Cathriona Foley

Lyons *et al*. (2013) showed that 3-way strip grazing resulted in 31% reduced milking interval, 40% greater milking frequency, 20% greater daily milk production and greater utilization levels of the AMS milking units throughout the day compared to 2-way strip grazing. Seven farms throughout Ireland were monitored for their performance. They differed in grazing system, farm area, grazing area and number of cows. Results of milk production and milking frequency showed a huge variation with differences up to 200% between individual farms.

Lyons N.A., Kerrisk K.L., Garcia S.C. (2013) Comparison of 2 systems of pasture allocation on milking intervals and total daily milk yield of dairy cows in a pasture-based automatic milking system. J. Dairy Sci. 96: 4494-4504.

4.6 AMS and cow traffic

Henri Kohnen

The objective of this study was to adapt cow traffic to pasture intake and AMS utilisation. Two main routes were distinguished:

- Low pasture intake (< 10 kg DM cow^{-1} d^{-1} and/or AMS utilisation < 60 cows AMS^{-1}: simplified traffic and infrastructure: single tracks, selection gate robot exit, simplified paddock rotation;
- High pasture intake (> 10 kg DM cow^{-1} d^{-1} and high AMS utilisation >60 cows AMS^{-1}: sophisticated traffic and infrastructure: AB(C) with double main track, selection gate pasture return, half day paddock rotation.

Four monitor farms successfully improved cow traffic. Solutions were farm specific. It is concluded that AMS and grazing is possible and that cow traffic is a key factor.

4.7 Summary of group discussions

Discussion items

Five groups of about 10 persons discussed the following items:

- High yielding herds, automatic milking and grazing - is it possible to combine? What are reasons to stop and what are reasons to continue?
- Farm sizes increase. What is the best strategy to maintain the combination AMS and grazing? Can it still be done with 3 robots?
- What are the key performance indicators of the combination AMS and grazing? What is the best grazing system? (continuous, strip, ...)
- What should be included in a Decision Support Tool for grazing and AMS?

High yielding herds, automatic milking and grazing - is it possible to combine? What are reasons to stop and what are reasons to continue?

- Yes, it is possible to combine grazing and AMS. Reasons to continue: public perception of grass fed cows, cow welfare. Reasons to stop: land area and feed supply – too many cows.
- Yes, it is possible to combine grazing and AMS. From the technical point of view (milk yield, pasture utilization) research in Europe (France, Belgium, Ireland, Denmark, Sweden, the Netherlands) has shown that grazing and AMS systems can be combined successfully. Farmers stop grazing because they balance utilization of the AMS (milkings cow^{-1} day^{-1}) and investments associated with AMS.
- How to define 'high yielding'; per ha or per animal? Do we aim for high yielding herds or hectares of grasslands? Economic return is more important than high yields. There is a challenge to make AMS more economically efficient. There are good examples of AMS in combination with grazing, but in practice this occurs less.

Farm sizes increase. What is the best strategy to maintain the combination AMS and grazing? Can it still be done with 3 robots?
- Maintain individual units rather than grouping all together. Use the ABC or ABA system to ensure high grass utilisation.
- Robotic milking systems are still developing. Robotic milking is not a goal; it is a way to cope with shortage or expensive man-power, or a lifestyle decision which leads to relief of work pressure or flexible time management.
- New robotic systems are being developed for large scale farms, e.g. Robotic Rotary Milking which allows batch milking (milking groups of cows).

What are the key performance indicators of the combination AMS and grazing? What is the best grazing system? (continuous, strip, ...)
- Key indicators: kg grass eaten/robot, kg milk/kg grass eaten, kg milk/robot. Best grazing system depends on location and farm.
- It was concluded that 'Milk from Grass' or 'Conversion of grass to milk' is the most important key performance indicator. A dairy farm creates added value by converting low value feed into high value protein food, regardless of the milking system.
- The best grazing system is the system which results in the highest conversion of grass in milk. Probably intensive rationed grazing.
- Indicators: somatic cell count, number of cows to fetch, amount of milk produced from grass.

What should be included in a Decision Support Tool for grazing and AMS?
Automatic grass measurement and allocation to ensure high utilisation.

General remarks
Knowledge, both on the farmers' and on the advisors' side, is key when it comes to grazing and automation. Training and education focusing on grazing could improve the actual situation. Another important point is the fact that some farmers are afraid of combining grazing and automation and in those cases sensitive advisors that are able to cope with this fear and to convince the farmers are helpful. If a framework of education, politics and favourable land allocation is in place, grazing and automation with high yielding herds and several robots is possible.

5 Grazing and automation

5.1 What sensors can do for grazing

Gertjan Holshof

AM systems automatically collect a lot of data that are useful for daily management, e.g. visiting time, milking time, milk yield, conductivity, blood in milk, progesterone, urea, BHB, LDH. Activity sensors attached to leg or neck of cows can collect additional cow data. Leg mounted sensors provide information on walking (steps), lying and standing. Neck mounted sensors provide information on activity and feeding/grazing time. The feeding/grazing time can be determined from the angle of the neck in 15 minutes windows. The activity level is determined using movements of the head. In this way, an eating pattern over the day can be established for each individual cow or for a complete herd.

5.2 Potential benefits of sensors like RumiWatch to record grazing behaviour

Fredy Schori

Behaviour of cattle (grazing, lying, browsing, eating, ruminating, licking, drinking, vocalising, suckling, etc.) can be recorded and, via algorithms, translated into management information like total eating time, total chews, etc. Results of RumiWatch are validated using visual data collection. The data on behaviour provide information on the internal state of the cow (e.g. nutritional requirements, health) and the environment of the cow (e.g. sward state, climate). A potential benefit of sensors is that they can provide an estimate of the intake of grazing dairy cows, e.g. using:

- Intake = grazing time × intake rate
- Intake = bites × bite mass
    - Bite mass = *f* (herbage mass, herbage allowance, ...)

This information in combination with reference values is beneficial for advisers and farmers in improving the pasture management.

5.3 How can automation contribute to better dung pat disappearance in pastures?

Nick van Eekeren

This study aimed to improve dung pads disappearance and to improve herbage utilisation around dung pads. Tests were done on five sandy farms and five peat farms with the same dung. There were five treatments: with or without harrowing and water and an untreated control. Next steps are increasing the effect of water and reducing the water quantity. Sensors could be developed to recognise the dung pads in the field.

5.4 Development of Grasshopper for automated grass measurement

Diarmuid McSweeney

The Grasshopper is an easy to use and robust device for automated grass measurement. The development and use of the Grasshopper comprises of five steps:

- GPS map created and stored for each paddock;

- Calculate grass height and density in hectare;
- Input additional information required for calculation;
- Generate recommended grazing area and locate with GPS;
- Integration with PastureBase Ireland.

Integration with PastureBase will encourage PastureBase take-up, provide growth data at county or regional level, and provide historical data for future analyses.

5.5 Cow behaviour as a driver for automation

Bert Philipsen

There are a number of sensors available for behavioural observations, e.g. smarttag neck, SensOor and IceQube. Sensors can be used for two behavioural measures of interest:

- Fundamental aspects of behaviour – cow characteristics: e.g.
    - consistency of behaviours during grazing over time (e.g. time spent grazing, activity, rumination);
    - social dominance – 'assertiveness';
    - sociability, i.e. the motivation to be close to conspecifics;
    - temperament – 'fearfulness'.

    The latter (sociability and temperament) can be tested using behavioural tests.
- Practical aspects of behaviour: e.g.
    - relationship between behaviour (standing, lying, steps, grazing, rumination) and grass intake (assessed with marker assisted n-alkane method);
    - relationship between behaviour and characteristics of pasture (e.g. sward height, herbage mass).

Virtual electric fencing is another option using sensors, where sensors are used to manage grazing behaviour and where cows respond to sound ("Auto Border Collie 2.0").
Increased understanding of cow behaviour can help to further develop and improve strategies for automation in pasture-based dairy farming.

5.6 Self supporting grazing farm – cow guide

Paul Galama

A self-supporting grazing farm could have a number of features:

- Sensors measuring data on soil and grass
- Sensors measuring cow behaviour like grass intake
- Virtual fence regulating the supply of grass
- Sensors for supplement feeding and milk production
- Smart software implementing all data
- Cow guide/advice system on grass supply and supplement feeding
- Management of grazing farms on different locations

5.7 Summary of group discussions

Discussion items

Five groups of about 10 persons discussed the following items:

- What is the most urgently needed innovation with respect to grazing and automation?
- There are many developments with respect to (automatic) measuring of grass allowance and grass intake (at herd level and at cow level) in different countries (see for example EGF proceedings). What can we learn from each other? What are the best methods? (drones, plate meters, satellites, sensors etc.)
- Cow traffic. How to "move the cows"? What can attract them in the barn and what in the pasture?

- What technology is available in the different countries to assist farmers in optimizing (AMS and) grazing? Maybe something is mainstream in one country while it is innovative in another country.

What is the most urgently needed innovation with respect to grazing and automation?

- Do we need more? Use existing tools; make them more accurate, consistent. Innovations that reduce labour would be useful.
- Key words in the opinion of the group members:
  - Drones;
  - Non-destructive grass quality analysis;
  - Improve grass supply;
  - Help farms improve grazing;
  - Prediction of grass growth;
  - Regulate supply of feed;
  - Cow traffic management;
  - Knowing what grass is available.

  There was discussion on how useful it is to be able to predict future grass growth and to analyse grass quality remotely.
- Opinion of farmers: technology is nice, but it has a price. So apparently it is hard for them to see the added value/benefit yet.
- With regards to conditions of innovations we need information/data that is real-time and automatically obtained, translated into decisions/management for farmers. So “what is happening in my cows’ pen/meadow and what do I need to do now/tomorrow/next week?”
- Knowing grass growth, grass utilisation, grass quality, grass yield.
- Most urgent point: knowing grass intake.

There are many developments with respect to (automatic) measuring of grass allowance and grass intake (at herd level and at cow level) in different countries. What can we learn from each other? What are the best methods? (drones, plate meters, satellites, sensors etc.)

- Tools useful for grazing should be targeted at either “new grazers” or “experienced grazers”: they have very different requirements. Innovations should give farmers more control, e.g. through quick information to help decision making.
- New research is being done to predict grass intake from milk profiling and also from cow behaviour. Another method is back calculating grass intake from on-farm data. There are lots of data collected by AMS and feeding systems on farms, so back calculation may be a cheap and easy method for farmers.
- Techniques of measuring grass intake:
  - in the milk (fatty acids, other markers) (best);
  - on the cow (bites, head position, etc.);
  - on the field (drones);
  - combinations of different methods.

Cow traffic. How to “move the cows”? What can attract them in the barn and what in the pasture?

- Virtual fencing is an option. Public perception issues around electric halters on cows should be taken care of. Experience from Ireland is that it is extremely difficult to get cows to know what is expected of them with virtual fencing unless there is also a visual cue (such as a string laid across the ground). This somewhat defeats the purpose of a virtual fence.
- Regularity and training of cows.
- Auto Border Collie on the ankles of the cow to drive them forward or to steer them left or right (out of the box idea).
- Fresh grass outside and feed inside.
- Cow traffic: To steer or motivate the cows in and out from pasture is best made by a) fresh grass to attract the cows out and b) shortage of grass to attract the cows indoor (combined with the knowledge of the cow that after passing the robot new fresh grass is served outdoor again).

What technology is available in the different countries to assist farmers in optimizing (AMS and) grazing? Maybe something is mainstream in one country while it is innovative in another country.

- Some useful programmes:
    - PastureBase Ireland;
    - Utilisation calculator AMS;
    - Grazing project: feeding and grazing calendar (Luxembourg);
    - Dairy NZ.
- It would be very useful to have an inventory of all the tools available, both free tools and paid tools.
- Lely grazeway gate.
- Selection gates (but support for farmers is needed).
- Internet (but hard to find the overview and farmers do not (know how to) search themselves).
- Easy thumb rules for farmers to optimize the AMS, e.g. 2.3 – 2.5 milkings day^{-1}, and other easy numbers you can get from the AMS.
- Strengthening of the extension system (e.g. study groups, training of the extension workers so that they can teach/coach farmers to optimize grazing and AMS).

6 Concluding remarks

Evaluation of the day
The meeting was considered to be positive. The discussion sessions were greatly appreciated. It is good to meet people and to know what they are working on. Further exchange between researchers was encouraged. The EGF Working Group “Grazing” is a valuable platform for this.

Reporting
The proceedings (this report) and the pdf’s of the presentations are available on the website of EGF (www.europeangrassland.org/working-groups/grazing).

Continuation of the Working Group “Grazing”
It was discussed whether or not the Working Group should continue their meetings and it was generally felt as a good idea to continue the meetings. The EGF Working Group “Grazing” should continue to exchange knowledge, methods and innovations and should continue to network. Several potential future topics were mentioned and the next meeting of the Working Group “Grazing” was scheduled for 2016, prior to the 26th General Meeting of EGF in Trondheim, Norway.

References

Proceedings of earlier meetings of the EGF Working Group “Grazing”

Van den Pol-van Dasselaar, A., A. de Vliegher, D. Hennessy, J.L. Peyraud, J.B. Pinxterhuis, 2011. Research methodology of grazing. Proceedings EGF Working Group Grazing. Report 405. Lelystad, Wageningen UR Livestock Research, 19 pp.

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Van den Pol-van Dasselaar, A., A. de Vliegher, D. Hennessy, J. Isselstein, J.-L. Peyraud, 2015. The future of grazing. Proceedings third meeting of the EGF Working Group "Grazing". Report 906. Wageningen, Wageningen UR Livestock Research, 39 pp.

Appendix 1 Agenda 4th Meeting of the EGF Working Group "Grazing"

***Grazing and automation,* Wageningen, 14 June 2015**

Session I (chaired by Agnes van den Pol-van Dasselaar) (9.00 – 9.30)
Introduction
- Welcome, introduction of participants, introduction of the day
- State of the art with respect to grazing in Europe (Agnes van den Pol-van Dasselaar)

Session II (chaired by Johannes Isselstein) (9.30 – 11.15)
Grazing and EIP-AGRI Focus Group Permanent Grassland (short introductions)
- The European Innovation Partnership "Agricultural Productivity and Sustainability" (EIP-AGRI) (Remco Schreuder)
- Reflections of members of the EIP-AGRI Focus Group Permanent Grassland (Piotr Goliński)

Group discussions
Plenary discussion / feedback

Session III (chaired by Alex de Vliegher) (11.15 – 14.30, including lunch)
Grazing and automatic milking (short introductions)
- Short overview autograssmilk (Frank Oudshoorn)
- High yielding herds, automatic milking and grazing - is it possible to combine? (Eva Spörndly)
- Grazing management in an AM system (John Shortall)
- Video Liège: transporting an AMS
- Monitor farm benchmarking for integrating an AMS and grazing in a spring calving herd in Ireland (Cathriona Foley)
- Grazing and automatic milking: Improve voluntary cow traffic on the monitor farms (Henri Kohnen)

Group discussions
Plenary discussion / feedback

Session IV (chaired by Deirdre Hennessy) (14.30 – 16.45)
Grazing and automation (short introductions)
- What sensors can do for grazing (Gertjan Holshof and Bert Ipema)
- Potential benefits of sensors like RumiWatch to record grazing behaviour (Fredy Schori)
- How can automation contribute to better dung pat disappearance in pastures? (Nick van Eekeren)
- Automated geo tagging grass measuring device – Grasshopper (Diarmuid McSweeney)
- Cow behaviour as a driver for automation (Bert Philipsen)
- Amazing Grazing in 2030 (Paul Galama)

Group discussions
Plenary discussion / feedback

Session V (chaired by Agnes van den Pol-van Dasselaar) (16.45-17.00)
Closure of the meeting

To explore the potential of nature to improve the quality of life

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