Grazing in a high-tech world

Proceedings 5th Meeting EGF Working Group “Grazing” in Trondheim

A. van den Pol-van Dasselaar, A. de Vliegher, D. Hennessy, J. Isselstein

REPORT 1079

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Wageningen Livestock Research
Wageningen, December 2017

Report 1079

Van den Pol-van Dasselaar, A., A. de Vliegher, D. Hennessy, J. Isselstein, 2017. *Grazing in a high-tech world; Proceedings 5th Meeting EGF Working Group "Grazing".* Wageningen, Wageningen Livestock Research, Livestock Research Report 1079.

This report presents the main outcomes of the fifth meeting of the EGF Working Group “Grazing” which was held in Trondheim, Norway on 4 September 2016. The aim of the Working Group “Grazing” is to exchange knowledge on all aspects of grazing research and to provide a forum for networking. The theme of the meeting in Trondheim was “Grazing in a high-tech world”.

This report can be downloaded for free at https://doi.org/10.18174/431562 or at www.wur.nl/livestock-research (under Wageningen Livestock Research publications).

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Wageningen Livestock Research Report 1079

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Foreword

The fifth meeting of the Working Group “Grazing” of the European Grassland Federation (EGF) was held in Trondheim, Norway, in September 2016 prior to the 26th General Meeting of the European Grassland Federation. The theme of the meeting was: “Grazing in a high-tech world”. 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, as in previous meetings, 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 outcomes of the fifth meeting of the EGF Working Group “Grazing” which was held in Trondheim, Norway, on 4 September 2016. 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 Trondheim was “Grazing in a high-tech world”. There were four sessions:

- Welcome / introduction / state of the art of grazing in Europe 2016
- Our high-tech world
- High-tech methods
- How to reach (young) farmers in a high-tech world?

The participants shared many research results, ideas and thoughts on these topics, which are summarised in this report. Grazing in a high-tech world is challenging, but also provides new opportunities to optimise grazing.

1 Introduction

Dairy farmers face many challenges. One of them is to optimise daily grazing management of their dairy cows. In the current era, grazing management and research into grazing management can be supported by high-tech solutions. The topic “Grazing in a high-tech world” is a relevant topic both for science and practise. It includes high-tech solutions in grazing experiments and in practise, e.g. working with sensors, extensive data acquisition, complex models, apps, etc.

The topic “Grazing in a high-tech world” was discussed during the fifth meeting of the EGF Working Group “Grazing” in Trondheim, Norway, 2016. This Working Group ensures detailed knowledge exchange and discussion on grazing. The group was established in Uppsala, Sweden at the General Meeting of the EGF in 2008. Subsequent meetings were held in:

- Kiel, Germany, 2010: Research methodology of grazing
- Lublin, Poland, 2012: Innovations in grazing
- Aberystwyth, UK, 2014: The future of grazing
- Wageningen, the Netherlands, 2015: Grazing and automation.

Proceedings of all meetings can be found at www.europeangrassland.org/working-groups/grazing.

In Trondheim, there were 52 participants from 14 European countries present during the meeting. The majority of the participants were from research, but there were also other stakeholders present, e.g. from industry. There were four sessions during the meeting:

- Welcome / introduction and provision of data on grazing in Europe in 2016
- Our high-tech world, which provided an overview of available technology in different countries
- High-tech methods, which gave insight in the use of technology in research
- How to reach (young) farmers in a high-tech world? This final session approached high-tech from a different point of view, focussing on high-tech options to get the available knowledge to students and young farmers.

The last three sessions consisted of plenary presentations followed by a short plenary discussion. Thereafter, the theme was thoroughly discussed in groups of about ten persons each.

Both the plenary presentations and the group discussions are summarized in this report. The state of the art of grazing in Europe is described in Chapter 2. Chapter 3 reports on our high tech world. Chapter 4 reports on high-tech methods. Chapter 5 reports on how to reach (young) farmers in a high-tech world, 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 Trondheim in 2016.*

2 State of the art of grazing in Europe - 2016

Agnes van den Pol-van Dasselaar, Wageningen Livestock Research / Aeres University of Applied Sciences, the Netherlands

Data on grazing in Europe are not easily available. Generally, in Europe grazing is seen as an economically attractive activity (e.g. Dillon *et al.*, 2005; Peyraud *et al.*, 2010). However, the extent of grazing is highly variable. It is obviously depending on a number of technical factors, like available land area for grazing and number of dairy cows present. Changes in those technical factors could lead to changes in the extent of grazing per cow. However, technical factors are not the only influencing factors. Farmers play a key role in determining the extent of grazing of their dairy cattle since they decide on the day to day management on their farm. From on-farm participatory research, it is known that personal values, preferences, experiences and habits of farmers are very important in the decision whether to graze or not to graze (e.g. Reijs *et al.*, 2013; Van den Pol-van Dasselaar *et al.*, 2016). The mind-set of the farmer thus influences the extent of grazing (Figure 2).

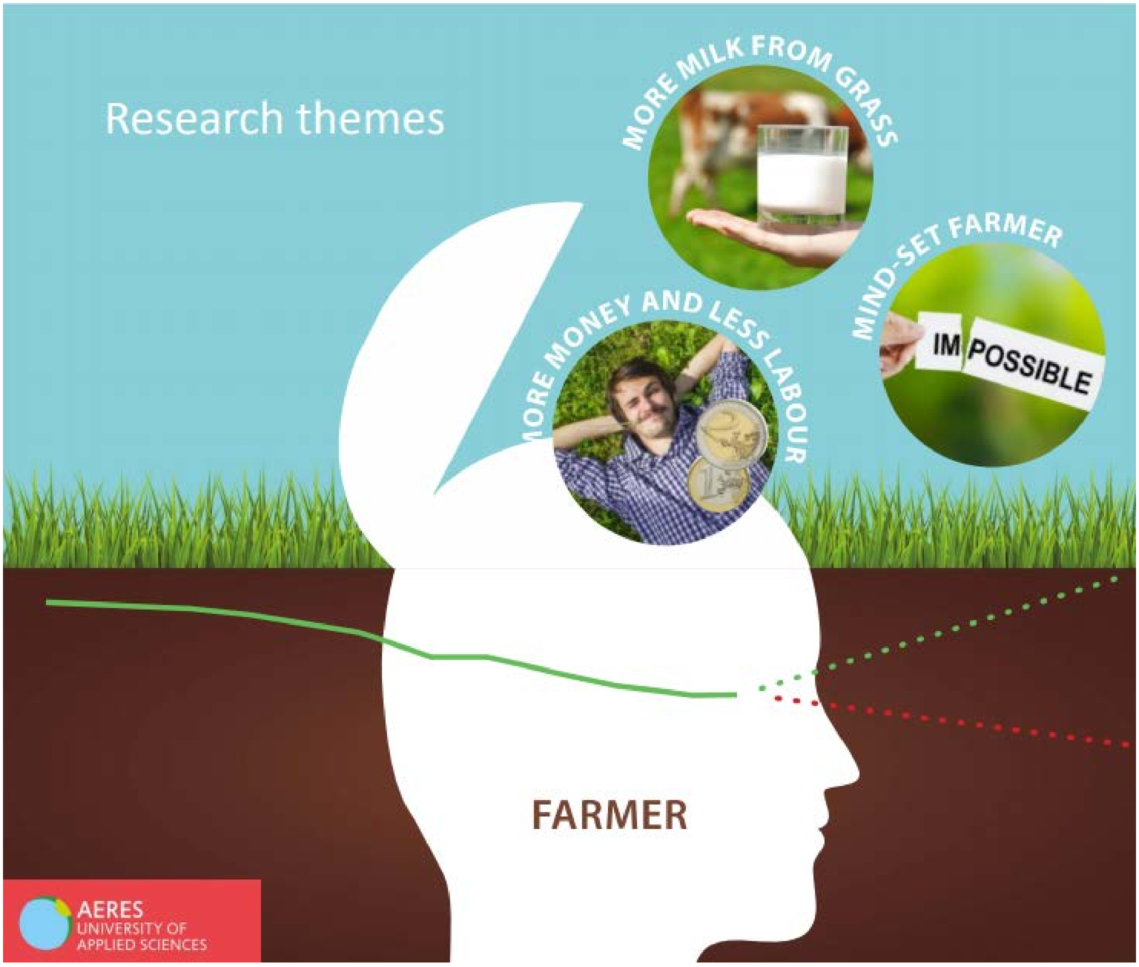

***Figure 2**.* *Factors affecting the extent of grazing and associated research themes: technical factors (more milk from grass), economy and labour (more money and less labour), mind-set farmer; Figure 2 is based on Van den Pol-van Dasselaar, 2016.*

Since the first meeting of the EGF Working Group “Grazing” in 2010, surveys on the extent of grazing in different countries 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, in these surveys 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.

In 2016, a survey was carried out among the members of the Working Group using SurveyMonkey. The total number of respondents was 93, but only 88 respondents completed the full questionnaire. The majority of them (more than 50%) responded that the numbers provided were an educated guess. Based on the results, Europe can be divided into six distinctive regions with respect to grazing (Table 1).

Table 1. *Grazing in Europe (% of dairy cows) in six distinctive regions of Europe. Data are mainly educated guesses from members of the EGF Working Group "Grazing".*

North	Norway	90% in 2016, slightly decreasing
	Sweden	100%, welfare legislation, cows have to be outside for between six weeks and four months
	Finland	70% in 2016, cows in tie stalls have to be let outdoors for 60 days between 1 May and 30 September
West	Ireland	99% in 2010 and 2011, 98% in 2014, 95-100% in 2016, stable
	UK	92% in 2013, 80-90% in 2016 (95% in Northern Ireland and 70% in Wales in 2016)
Central; Grazing > 50%	The Netherlands	90% in 2001, 70% in 2014, there is an increase in activities supporting farmers that graze, including a grazing premium if farmers graze for at least 120 days and at least 6 hours per day
	Belgium	85-95% in 2010, 75-80% in 2014, 60-85% in 2016, more grazing in Wallonia than in Flanders, stable in Wallonia, decreasing in Flanders
	Luxembourg	90% in 2008, 75-85% free access in 2010, 73% in 2014, 75% in 2016, slightly decreasing
	France	90-95% in 2011, 90% in 2014, 75-95% in 2016
	Switzerland	85-100% in 2011, 75-90% in 2014, 80-97% in 2016
Central; Grazing < 50%	Denmark	84% in 2001, 70% in 2003, 40-50% in 2008, 35-45% in 2010, 30-35% in 2011, 25-30% in 2014, 25% in 2016
	Germany	42% of the milking cows are grazing in 2009, 10-50% in 2016
	Austria	25% in 2011, 40% in 2016, stable
East	Poland	20% in 2016, quickly decreasing
	Estonia	35% in 2011
	Lithuania	50-70% in 2014
	Czech Republic	20% in 2010, 3% in 2016
	Bosnia and Herzegovina	5% in 2011
	Slovenia	25% in 2010, 20% in 2016, slightly decreasing
	Hungary	70% of all LSU (cows, sheep, horses, goats) are grazing in 2010, 2-3% grazing dairy cows in 2016, stable
	Bulgaria	50% in 2016
South	Portugal	50% in 2010, increasing
	NW Spain	20% in 2010, 18.5% in 2014; 10-30% in 2016
	Greece	15% in 2010, less than 10% in 2011, 10% in 2016, slightly increasing
	Italy	10-20% in 2016, slightly increasing

Of all respondents of the survey, 33% thought that the percentage of grazing was stable and 20% thought that the percentage was slightly increasing. The majority (47%) thought that the percentage of grazing was decreasing, either slightly decreasing (42%) or quickly decreasing (5%). It was concluded that grazing is country specific and that there is less grazing in the East and the South than in the North and the West of Europe. Even though the data are often only an educated guess, it can be concluded that in general the popularity of grazing in Europe is declining, with less cows grazing less days per year and less hours per day.

The respondents of the survey considered grazing important for different stakeholders: farmers, government, scientists, teachers, students, the general public. On a scale of 1 to 10 (where 1 is unimportant and 10 is important), the importance of grazing for the different stakeholders was rated between 6 and 7. Respondents fully agreed with the proposition that grazing contributes to the image of the dairy sector and they agreed that grazing is profitable. However, they also agreed that management of grazing is more complex than management of full housing. Therefore, it would be good to develop technologies, and grass and cow measurements that could assist farmers. Top priority, according to the respondents, is the development of real time reliable grass intake measurements. Other technology that was mentioned included real time yield estimates / predictions of grass growth, real time forage quality measurements, GPS / monitoring of cattle behaviour and a fence that is easy to move.

3 Our high-tech world

3.1 Technology use in grazing management in Ireland

Emer Kennedy, Teagasc, Ireland

Ninety per cent of agricultural land in Ireland is in grassland. In excess of 90% of livestock (dairy and beef) graze these grasslands. Analysis of data from commercial and research farms has shown that pasture based systems are the most profitable and that the greater the proportion of pasture utilised the higher the farm gross margin.
Technology has consequently centred on trying to increase the proportion of pasture grown and utilised. One of the key developments to achieving this objective was the conception of PastureBase Ireland. This is a web based grassland management decision support tool at the front end but it has a grassland data base at the back end which can be used for research purposes. PastureBase Ireland was launched in January 2013 with an extension, advisory, and research focus. The database will facilitate the quantification of grass growth and DM production (total and seasonal) across different enterprises, grassland management systems, regions, and soil types. PastureBase Ireland supplies farmers with a number of reports (spring rotation planner, mid-season grass wedge, and autumn budget) that make day to day management decisions easier. It also allows farmers to evaluate medium to long term performance from the farm (distribution of growth and paddock summary reports). The reports can also be used to benchmark farms across enterprises and regions. The background data such as paddock soil fertility, grass cultivar, altitude, reseeding history, soil type, drainage characteristics and fertiliser applications are also recorded.

PastureBase IRELAND

In conjunction with Teagasc Moorepark a rising plate meter device has been developed known as the ‘Grasshopper’, with an ultra-sonic sensor to accurately and precisely measure compressed grass height, with recorded GPS coordinates. The sensor is placed on the shaft of the plate meter and this device measures the height of the grass (or plate) by recording the time for the sonic transmission from the ‘Grasshopper’ unit on the shaft and its reflective return from the circular plate. It further has the capacity to transfer generated data automatically to a SMART device and then to PastureBase Ireland. It then calculates the grass cover in the paddock. It was calibrated and validated for measurement of grass height against the New Zealand plate meter, the Jenquip. The Grasshopper also records where in the field the sample was taken and displays the route the farmer has followed in taking his recordings. The device will ‘communicate’ with a mobile phone or tablet to display the route taken allowing a farmer to confidently delegate grass measuring to on farm staff. A mobile application allows the farmer to survey paddocks and display paddock maps with real-world coordinates in real time giving the farmer up to the minute detailed information on grass availability on farm. Using this information the farmer will be able to achieve an accurate and precise grazing allocation.

3.2 Amazing Grazing; high-tech grazing in the Netherlands

Marcia Stienezen, Wageningen Livestock Research, the Netherlands

The Dutch project Amazing Grazing (www.amazinggrazing.eu) studies and develops a number of high-tech options: prediction of grass growth, measuring grass supply with drones, virtual fencing, estimating dry matter intake using cow sensors and decision support tools like “Grip op Gras” that support the grazing management of farmers with tools like feed wedges and farm maps.

3.3 Decision tools and services for grassland nutrient management

Emer Walker, Yara International

As a global provider of sustainable crop nutrition solutions, Yara supports farmer profitability through knowledge, optimal quality and productivity. Through the combination of extensive crop knowledge, differentiated product portfolio and high-tech tools and services, Yara optimizes the nutrient management of crops.

In the case of grassland, Yara’s specially developed grassland product portfolio ensures that essential nutrients for grass quantity and quality, as well as animal performance and health, are supplied in the balanced crop nutrition programs.

Yara assists farmers to optimize the nutrient management of their crops by eliminating the guesswork regarding fertilizer timing and rates. Yara is currently focusing on developing tools and services for use in grassland. Trials using these tools have already been conducted in Germany, Finland and the UK. Together with cooperation partners at the Universities of Bonn, Cologne and Wageningen, further trials are ongoing.

Quality, as well as quantity, is of fundamental importance for grass production. Plant tissue and soil analysis provide valuable information which can be used to optimize a specific fertilizer program. Megalab is an internet based analytical service offered by Yara which delivers accurate results in an easy to interpret format along with recommendations.

Yara is developing a new online portal, which acts as the gateway to Yara’s tools and services. All of the measurements, readings and analyses from Yara’s tools and services will be combined together to create a complete nutrient management solution for the farmer.

3.4 Summary of group discussions

Discussion items

Five groups of about 10 persons discussed the following items:

- Farmer skills versus technology:
    - Is it important to understand the basic skills of grassland management before employing technology?
    - Is technology a distraction when it comes to learning good grassland management skills?
- Ethics versus technology
    - Animal welfare (natural behaviour, animal health)
    - What might become animal welfare issues?
- Nature/environment versus technology
    - Aesthetics, emission risks of systems, etc.
- Do you see other issues? (clear disadvantages or advantages)

Farmer skills versus technology

- Why "versus"? Better "plus"; both are necessary and interacting
- Basic skills are needed; don't rely blindly on technology without knowing what the outcome should be (within a range). Grassland situations are very different across Europe. Different grassland situations require different grazing systems.
- In contrast to other agricultural fields, young farmers know less about why and how grassland systems, and grazing systems in particular, should and could be managed with modern technologies. Grasslands, and again in particular grazing, often look like a black box to them, instead of a challenge of where and how they could go new ways. The time available for teaching and training at universities and in workshops is often very short and grazing is not always of particular interest to students and farmers. Grazing must be made appealing for young farmers.
- Technology can help to improve management results but also to stimulate the learning process of students and to make this learning process more interesting
- Knowledge exchange among grazing farmers should be encouraged
- Impact of the "neighbour" is sometimes underestimated. If the neighbour is still in barn, why is it better if I graze?
- The older generation (in some countries a lot of farmers or even most of the farmers are over 50 years) started years ago to focus on feeding and producing milk. The younger generation already has more interest in grazing, but it is difficult to convince the father/older generation
- When dealing with grazing systems other points instead of (new) grazing technologies are raised, like supplemental feeding and adaptation of fertilizing to grazed pastures
- New grazing technologies must save labour and must produce confidence

Ethics versus technology

- Discussion in terms of animal welfare:
    - Sensors are needed for detection of animal welfare parameters. But animals carrying several sensor systems would not be highly appreciated by the society
    - Poisonous plants should be detected
    - Virtual fencing should be developed, but there are ethic concerns in the society
- Use of sensor data has a positive effect on animal health, due to quick response
- Technology that leads to pain or technology that disturbs 'normal' cow behaviour should be avoided
- Can technology be manipulated in a wrong way?
    - Individual (as the data of a farmer are used to control the farmer)
    - By the providing industry/pharmacies
    - Political
- Use of picture material: impact on privacy when tourists or other persons in the surrounding area of a farm are filmed or photos are made
- What you see (as consumer/tourist/etc.) makes what you think: people think that cows in a natural surrounding have no (health) problems, so no technics on an animal should be needed. So: prepare the public by consumer information about the use of technology in an agricultural system

Nature/environment versus technology

- Advantages: better use of nutrients, reduction of emissions in the barn
- New technologies should help to manage cutting (meadows) and grazing (pastures) as well as mixed parcels (grazed and cut) within a farm
- No pollution, radiation and so on from technology
- Climate change consequences, according to the situation of the different regions, e.g. heat stress
- Use of drones: noise. When the use is more common: higher risk of collapsing
- Improving farm results with the use of technology can:
    - Decrease biodiversity (the whole area the same high production)
    - Give chances to distinguish good production parts of the farm from more marginal parts and to adapt the management to that specific areas/plots

Other issues (advantages or disadvantages)

- Advisors should be integrated in the discussions, in teaching and in training
- New technologies of particular interest: remote sensing, drones
- Specifics of big herds
- Keep grazing systems as simple as possible and easy to establish on the farm
- Standardization (techniques, terms, handling, adaptability to other farm systems)

- Don´t forget sheep and goat in the grazing discussion!
- Education/advisory versus technology
- The use of high-tech has to rely on education and well-validated tools. Both advisors and farmers have to be trained.
- There is a need to standardize all data from individual tools on at least European scale: new European project?
- High-tech is not an objective itself but it can be an opportunity to improve the management of the system
- High-tech should help to reduce the production costs
- High-tech can be an interesting and appealing tool to record data and reduce the "annoying" work on the farm

4 High-tech methods

4.1 Grazing on the North Wyke Farm Platform – the world's most instrumented farm

Robert Orr, Rothamsted Research, North Wyke, Okehampton, Devon, UK

The world needs innovative solutions for the sustainable intensification of its major agricultural systems. The North Wyke Farm Platform (NWFP) http://www.rothamsted.ac.uk/farmplatform (Orr *et al.*, 2016) represents a large investment in the UK by BBSRC in the future, to not only study but also improve grassland livestock systems in a national and global research asset linked to real-world farming. The Farm Platform is a world-class facility and a key member of the Global Farm Platform (http://www.globalfarmplatform.org/) which attracts researchers from different communities and disciplines seeking to develop sustainable ruminant production systems (Eisler *et al.*, 2014). It provides access to a range of in situ state-of-the-art instrumentation (Griffith *et al.,* 2013) in hydrologically-isolated catchments to better address key issues in sustainable agriculture related to:

- Replacement of N fertiliser with N-fixation by legumes
- Using plants to manage soils and hydrology in green-engineering solutions to flooding
- Efficient phosphorus cycling in grassland systems
- Resilience of soil biota and their functions in land-use change
- Impact of grassland management on C cycling and storage - C sequestration
- Water resource use efficiency
- Systems modelling to design optimal grassland production systems

The NWFP provides three farming systems in farmlets, each consisting of five component catchments comprising approx. 21 ha in total per farmlet. Each farmlet is continuously stocked with dedicated yearling beef cattle and ewes and their lambs and managed using alternative approaches to livestock production from grassland:

- Permanent pasture: improvement through use of inorganic fertilisers
- Increased use of legumes: replacing nitrogen fertilisers with biological fixation
- Planned reseeding: regular renewal, providing opportunities for introducing innovative varieties with desirable traits. Currently, high sugar grasses and deep rooting grasses are studied.

Measurements on water, air and soil are also recorded to provide metrics of sustainability. Much of this data has a high (15 min) temporal resolution, such as water flow and water chemistry data measured at a flume for each of the 15 catchments. As a UK National Capability, the data collected are made publicly available at https://nwfp.rothamsted.ac.uk/.

Conclusion. The Data Portal for the NWFP provides a robust and powerful tool to visualise and obtain data from a highly-controlled temperate lowland grassland beef and sheep system where the impact of the livestock on nutrients leaving the systems are precisely quantified in a world-class facility.

Acknowledgement. NWFP is a UK National Capability funded by the Biotechnology and Biological Sciences Research Council (BB/J004308/1).

4.2 Grazing cows: what are they doing when and where? First experiences with a GPS and activity sensor

Bettina Tonn, Christopher Noll, Anja Schmitz and Johannes Isselstein, Institute of Grassland Science, University of Göttingen, Germany

Interactions between grazing animals and grassland sward typically have great spatial and temporal heterogeneity with potentially profound effects on vegetation composition and nutrient cycling. GPS collars and activity sensors provide a research tool to investigate animal interaction with the pasture at great spatial and temporal resolution.
We equipped a total of nine cows grazing on three experimental pastures of 1 ha each with Vectronic GPS Plus Collars with three-way accelerometer (Vectronic Aerospace GmbH, Berlin, Germany) from 9/5 to 23/6/2016. Position was logged every 60 s and activity integrated over periods of 64 settings. We compared three settings of the activity sensor: mean forward and sideways activity (1), proportion of time that a predefined threshold value for head angle and three-axis activity was exceeded, where these thresholds were set either low (2) or high (3). Assessment of measured activity values and preliminary comparison with animal behaviour observation indicated that setting (1) and (2) were suitable for distinguishing between “active” behaviour (grazing and walking) on the one hand and “inactive” behaviour (standing and lying down) on the other hand.
Diurnal activity patterns, averaged over the whole observation period, showed clear periods of high activity (especially 6:30-8:00 am and 7:00-10:00 pm) and low activity (especially 11:00 pm - 5:00 am and 10:00-11:00 am), independent of activity measurement setting (1 or 2). Heat maps of animal location during these four periods revealed very strongly preferred areas for periods of low activity in all three paddocks, while animals were more evenly distributed during the periods of high activity. First graphical assessments indicate that animal location patterns during periods of high activity may be related to the mosaic structure of the grassland sward with more observations in short than in tall sward areas.
We conclude that, while acquiring the required technical and analytical expertise to work with animal GPS and activity sensor data is not trivial, these technologies are promising for the analysis of spatial grazing behaviour even at relatively small scales.

4.3 Experiences with the pH-sensors eCow and Smaxtec

Fredy Schori and Andreas Münger, Agroscope, Switzerland

Subacute rumen acidosis is a widespread nutritional disorder. It occurs not only with high-yielding dairy cows with high concentrate supplementation or very energy dense rations, but also under grazing conditions. Subacute rumen acidosis is associated with a decrease in dry matter intake, in milk production and in body condition score as well as with rumenitis, laminitis, immunosuppressive disorders etc. Through rumenocentesis or rumen tubes, spot pH measurements of rumen content are possible, but to draw conclusions about rumen fermentation state with one or two pH measures per day per cow is difficult. In addition both interventions are not trivial and especially with the rumen tube saliva contamination can be a problem. Graf *et al.* (2005) developed a method to measure pH continuously and studied the effects of forage supplementation of grazing dairy cows. Later, Falk *et al.* (2016) compared the Lethbridge Research Centre ruminal pH measurement system (LRCpH) with a telemetric bolus (eCow®). The eCow bolus is administered orally and usually stays in the reticulum; the LRCpH, is designed to be inserted in the rumen through a cannula and tethered to it. It has to be taken into account for further interpretation of results, that pH measurements taken in the reticulum were overall higher compared to those from the rumen. The diurnal pH variation in the reticulum was less and the variation between animals was smaller compared to the rumen.
In a recent experiment the pH measurement accuracy over 150 days of eCow boluses (e-Bolus, eCow Devon Ltd, UK) and Smaxtec boluses (Smaxtec pH and Temp Sensor, SmaXtec animal care sales GmbH, A) were investigated. For this purpose, four boluses, two eCow and two Smaxtec, were placed in a bundle and tethered in the rumen of each of three ruminally cannulated lactating dairy cows. At the beginning of the validation and every 14 days afterwards, until 150 days, boluses were laid first in a pH 4 standard buffer solution for at least 3 hours, subsequently in a pH 7 standard buffer solution

and finally returned to the rumen. The automatic readout of the Smaxtec bolus records worked well. After 150 days all Smaxtec boluses stopped to record pH. The company specified the pH measurement accuracy as ±0.2 up to 90 days and ±0.4 up to 150 days. In 80% of the cases the pH of the buffer solution 7 was underestimated with the Smaxtec boluses and in 50% of the cases the pH differences were outside the stated measurement accuracy. With the buffer solution pH 4 the results were even worse. With the eCow boluses several technical problems happened. Normally, the eCow boluses would start measuring pH, if the ambient temperature is above 30°C. Apparently, the boluses were activated before they arrived and continued to measure pH, although ambient temperature was below 30°C. Thus, the six eCow boluses ran only between 28 to 128 days during the validation experiment. If run-time before the experiment was included, the boluses recorded pH between 68 to 166 days. Additionally, there were serious difficulties with the radio readout of the data. The antenna for reading the data had to be replaced twice. In the meantime, the radio problems have been solved. Finally, with one eCow bolus, completely erratic data were obtained. More detailed evaluations are currently performed.

4.4 Dosing n-alkanes: New methods imposed by labour safety legislation

Ronald Zom, Wageningen Livestock Research, the Netherlands

New methods have been developed in the Netherlands to mix n-alkanes with concentrates for use in grazing experiments. These methods include:

- Top dressing of n-alkane on soybean meal
- Heating in an oven
- Cooling down to create “cakes”
- Crumbling of the cakes in a mill
- Inclusion in a compound feed

4.5 Summary of group discussions

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

- In what areas is there potential to develop new technologies?
- What can we learn from technologies in other disciplines?
- What is the potential of technology to improve our understanding of grazing? How do we overcome problems?

In what areas is there potential to develop new technologies?
There is potential to develop new technologies in potentially any area connected to grazing dairy animals. The development of informatics is very fast. Perhaps we cannot imagine presently the new achievements on the mid-term. In spite of that, the discussion group identified three potential fields:

- research
- farmers every day’s work
- communication channels between the actors of grazing business

Heat stress is a good example where we need to develop new technologies. There seems to be a need to monitor heat stress in dairy cows, e.g. by measuring body and rumen temperature. How can we measure the temperature on small scale in the pasture and how do cows react on temperature differences? (this is important for the pastures with higher and lower parts). Can we learn from (and use) technologies of the plant scientists: e.g. infra-red measurements of the plant temperature. How can we use technology to optimise the energy flux from the sun through plant and animal? There are knowledge gaps between the different production levels (soil-plant-animal-product): how can technology help to fill these gaps? Use the knowledge and development of technologies, sciences and practice and combine these in multidisciplinary research. In conclusion: we need multidisciplinary research for system analyses or (and) vice versa, system analysis will change/influence the research methods/organization.

What can we learn from technologies in other disciplines?
The discussion was going on around two topics:

- How can we use existing technologies?
- It should be proven for the actors, mainly for the farmers, that new technologies can really help!

Do we know what we don't know? Let others have a look at our situation, system or problem.
How can we combine data from different resources to improve the production or improve the utilization of the nutrients. In conclusion: we can learn a lot, but probably we don't know what we really need. So invite other disciplines with e.g. plant or industrial knowledge (Philips / Google / Apple / Facebook) and learn from human and plant physiologists and scientists.

What is the potential of technology to improve our understanding of grazing? How do we overcome problems?
New technologies can help to understand the connection between areas connected to grazing. It is possible to have clear evidence on the usefulness of new technologies. This may be useful mainly for farmers having less experience.
Researchers and farmers see a beautiful pasture with good grass. But after one day grazing, there are parts of the pasture where cows didn't graze at all. The day after grazing we cannot see or decide why the cows didn't graze that part of the pasture. In our opinion it was perfect grass. But the nose, tongue or eyes of the cow made another decision. So we need more information about the taste and smell of the cow. In conclusion: the potential is huge. We however need "inside" information from the animals. We need an electronic "cow-nose" to understand the 'cow-graze-system'.
There is a secret for the success of new technologies. The invention of new technologies accounts for only 30%, but communication of the new technologies with farmers represents at least 70% in the success. Some more key points for success:

- Prove that the new technology leads to economic efficiency in the system
- „Neutral” (is non-one sided) communication on the usefulness of new technologies

5 How to reach (young) farmers in a high-tech world?

5.1 PISA case study

Paulo César de Faccio Carvalho, UFRGS, Brasil

The PISA case study shows how an innovation in grazing management can modify the complete production system at farm level. It is a concept of a production system based on sustainable intensification principles. This Extension Project, that combines science and practice, is now reaching 1050 small farmers in Southern Brazil.

5.2 Serious games and new technologies

Sébastien Couvreur, ESA, France

Are serious games and new technologies innovative tools to interest students for grassland management? It is often hard to teach students and train or advice (young) farmers to grassland or grazing management. To reach students and young farmers, it is important to:

- Focus on teaching of simple but important key messages of grassland management
- Teach the complexity of its management as a technical challenge
- Develop participatory and pluridisciplinary approaches

A serious game (Forage Rummy) was developed to teach forage system management. Key components of Forage Rummy are:

- Game-based approach for forage system design
- Farmers and advisors are the main players in livestock system design
- Simulation models
- Stimulation of discussion, analysis and learning about forage and livestock management

Evaluations of Forage Rummy by students were positive.

5.3 Efficient knowledge transfer in dairy production in the Netherlands

Jeroen Nolles, Aeres University of Applied Sciences, Dronten, the Netherlands

Dairy farms, farm advisory organizations and feed industry constantly change. This means that students from Applied Universities should continuously adapt to these changes. The University itself should continuously seek for more efficient methods of knowledge transfer.
The goal of future focused Applied Universities is to educate students to such a level that they provide added value for companies compared to their current workers. A new concept to educate future focused students has been developed. Competence based learning and the so-called 'Golden Triangle of cooperation' (cooperation between research and innovation, industry and education) provide an excellent basic for a new vision on education. The three basic steps of the new concept to educate students are:

- start in the future (about 8 years from now),
- implement soil based knowledge (soil type is the basis of a dairy farm), and
- learn from diversity (e.g. on the school Education Farm).

The new educational concept transforms efficient knowledge transfer to students into effective knowledge transfer to students.

5.4 Summary of group discussions

Discussion items

Five groups of about 10 persons discussed the following items:

- How to educate young people with respect to grazing?
- Can technologies make grazing more attractive to the new and future generations of farmers? In what way? What attract farmers to employ technologies?
- “Frontrunners” are always eager to implement new things, but what about the large group of farmers?

How to educate young people with respect to grazing?

This depends on the background of the students:

  - If they have a farm background: focus on benefits regarding economy and potential gain in quality of animal products
  - If they do not have a farm background: focus on ecosystem quality provided by grazed grassland

What is needed is to integrate plant and animal knowledge. Good basic skills are needed. Students need knowledge about the detailed components of grazing: animal, soil, plant and their interactions. This could be done by having more than one teacher at the same time in the same class. Furthermore, it is good to have group discussions, as grazing is a complicated subject.
The first action in educating young people is to teach the teachers.
It is very important to learn “in the field”. Take students outside and let them feel, look, taste and smell the grazing system.
The question should be: “How to interest young people?” Hungary and Czech Republic are experiencing that young people are less interested in agriculture, and also less interested in grazing systems. In contrast, Ireland and Italy are experiencing that some groups of young people are interested in farming. These young people are educated and have work, but when their parents get old they return to the family farm to keep on the tradition of farming. The Netherlands are experiencing that some young farmers have an increasing interest in grazing as it is the last part of farming that can be made more efficient. Swedish statistics show that an organic farmer is on average ten years younger, more often a female and has 10% more arable land compared to a conventional farmer. There seems to be some attractive factors for young farmers.

Can technologies make grazing more attractive to the new and future generations of farmers? In what way? What attracts farmers to employ technologies?

- If the technology makes life easier, it is of interest.
- Technologies are 'toys for boys'; they are a means to attract people's interest. For example, if you take a quad, the farmwalk is no longer a dull walk. Even small/simple technologies can attract attention of students.
- A technology is attractive when it is adapted to biological, social and economic needs. These needs differ due to e.g. climate and soil, farm structure and dependence on subsidies. There can be situations where technology is not the solution. Having grazing systems in very dry areas might be impossible due to a lack of water during the grazing period.
- Organize a grazing competition. Make a rank list of best grazers and publish it.
- Develop technology that is easy to use and that is robust. Technology should be problem-based, offering solutions for important problems.
- Showing results will stimulate farmers to do things better. Technologies should be used to solve knowledge gaps, thus improving the confidence of farmers in their actions. Be aware that problems may not be universal, but region-specific.
- Labour saving is important: technology should save (a lot of) labour to create extra time for other things, social life etc.
- Make the technology simple to use and easy to get access to. To reach the users of a new technology there is a need for good examples. It can be field demonstrations. It can also be new local businesses such as machine stations that offer the best available technology to be hired out with a professional driver for a fair price. Not every farm can afford to invest in new technology.

“Frontrunners” are always eager to implement new things, but what about the large group of farmers?

- The frontrunners are important as they are the entrepreneurs. They will inspire others, including researchers. But they will always be a few, far ahead of all others.
- Some things to remember:
    - Front runners are not always front runners owing to an advance in applying technology
    - Front runners may act as inspiration for other farmers, e.g. by stimulating testimonies in working groups of farmers
- Show that the technology leads to better economy
- Technologies with a large impact on (reducing) labour are accepted more easily
- Learn from colleagues rather than from advisors; study visits may be one way
- Good working and proven technology needs a rapid dissemination, that includes the communication of working and profits
- Accept that technology is not suitable for all types of farms and all types of farmers

6 Concluding remarks

Theme of the meeting
At the end of the day, it was concluded that grazing in a high-tech world is challenging, but provides many new opportunities to optimise grazing. Interaction between practice and science will lead to further technological developments. During the meeting, further exchange between participants was encouraged. The EGF Working Group “Grazing” is a valuable platform for this. The EGF Working Group “Grazing” should continue to exchange knowledge, methods and innovations and should continue to network.

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).

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Appendix 1 Agenda 5th Meeting of the EGF Working Group “Grazing”

AGENDA 5th meeting of the EGF Working Group “Grazing”
Grazing in a high-tech world
Trondheim, 4 September 2016

Start meeting at 9.00: registration, welcome, introduction of participants, introduction of the day

State-of-the-art
- Agnes van den Pol-van Dasselaar: Grazing in Europe 2016 (including results questionnaire)

Our high-tech world (chaired by Johannes Isselstein) (9.45 – 12.00 including coffee break)
Plenary presentations
- Emer Kennedy: High-tech solutions for grazing in Ireland
- Marcia Stienezen: Amazing Grazing; high-tech grazing in the Netherlands
- Emer Walker: Decision tools and services for grassland nutrient management

Group discussions and plenary feedback

Lunch (12.00-13.15)

High-tech methods (chaired by Alex de Vliegher) (13.15 – 15.00)
Plenary presentations
- Robert Orr: Grazing on the North Wyke Farm Platform – the world’s most instrumented farm
- Bettina Tonn: Grazing cows - what are they doing when and where? First experiences with a GPS and activity sensor
- Fredy Schori: Experiences with the pH-sensors eCow and Smaxtec
- Ronald Zom: Dosing n-alkanes: New methods imposed by labour safety legislation

Group discussions and plenary feedback

15.00 coffee break

How to reach (young) farmers in a high-tech world? (chaired by Agnes van den Pol-van Dasselaar) (15.15 – 17.00)
Plenary presentations
- Paulo César de Faccio Carvalho: PISA case study: how an innovation in grazing management can modify all the production system at farm level
- Sébastien Couvreur: Serious games and new technologies: innovative tools to interest students for grassland management?
- Jeroen Nolles: Efficient knowledge transfer in dairy production in the Netherlands

Group discussions and plenary discussion / feedback

Closure of the meeting at 17.00

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

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