Project number: 6338
Funding source: ICT-Agri Era-net
Date: Jan 2017
Project dates: Jun 2013 – May 2016

Use of ICT tools to capture grass data and optimize grazing management

Key external stakeholders:
Automated grass measurement, PastureBaseIreland, Virtual fence

Practical implications for stakeholders:

- Farmers can easily and quickly map portions of their farm as required
- The validated automated ICT grass measurement tool allows accurate, quick and easy grass measurement on-farm.
- The tool also assists in the uptake of the Decision Support Tool PasturebaseIreland, as the tool has the capability to upload the data directly to the PastureBase database
- This ICT grass measurement mechanism has the potential to increase the number of farmers measuring grass accurately.
- The validated tool can be satisfactorily used within conventional and automatic milking systems on dairy and on beef grassland farms
- The Virtual Fence (VF) prototype, with further development has the potential to control cow movement remotely and look to controlling individual cow grazing area.
- Thus, an ICT tool for grass measurement and a VF network infrastructure have been developed and further work will combine these technologies to advance the precision of grazing management in pasture based dairy systems

Main results:

- A validated automated ICT grass measurement tool (Rising Plate Meter type) with GPS capability has been developed that allows automatic recording of grass yield. The data can be transmitted to a SMART phone application. This automated tool allows accurate, quick and easy grass measurement on-farm.
- The principal of VF has been developed, the network infrastructure for VF has been developed and a demonstration of virtual fencing has been carried out.

Opportunity / Benefit:

The results of this research have:

- Demonstrated the possibility for automated routine grass measurement.
- Highlighted the advantages of having accurate grass yield data to make accurate grazing management decisions
- Assisted in increasing the uptake of PastureBaseIreland.
- Increased the possibilities for increased farm profitability through using accurate, real time data in grassland management decisions
- Progressed the testing and modification of the principle of VF technology in management and control of cow movement in intensive grazing systems, through GPS coordinate setting rather than the traditional method of physical barriers, e.g. structural or electrical fences.

Collaborating Institutions:

TEAGASC, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland
AGROSCOPE, Tänikon, 8356 Ettenhausen, Switzerland
INSTITUT DE L'ELEVAGE, 149, rue de Bercy, 75595 Paris, Cedex 12, Franc
TRUENORTH TECHNOLOGIES, Tullyglass Hill, Shannon, Co. Clare, Ireland

Contact Email: john.mee@teagasc.ie

Teagasc project team: Dr Bernadette O'Brien (Project Leader/PI)
Diarmuid McSweeney (Walshfellow)

External collaborators
Dr. Christina Umstatter, AGROSCOPE, Tänikon, 8356 Ettenhausen, Switzerland
Dr. Eric Pottier, INSTITUT DE L'ELEVAGE, 149, rue de Bercy, 75595 Paris, Cedex 12, France
Mr. Patrick Halton,TRUENORTH TECHNOLOGIES, Tullyglass Hill, Shannon, Co. Clare, Ireland

1. Project background:

The key drivers affecting grass utilised per hectare are grass growth and grazing management, including stocking rate. If profitability of grazing systems is driven by the degree of grass utilisation, which in turn is a function of both increased growth and optimum utilisation of that growth, the accurate and timely measurement of pasture is integral to effective grazing-management practice. Farmers, who rely on grazing pasture as their primary source of feed, require accurate and timely measurement of pasture biomass for effective grazing management. Pasture measurement tools (such as the rising plate meter) have been available but not routinely used on a widespread basis. Reasons include lack of confidence in their accuracy, high labour demand and difficulty in operation. Therefore a fast automated and accurate system was needed. This is much more complex than international dairy systems, where cows are primarily fed a mixed ration in confined housing. The development of parallel technology for precision feeding of animals within a pasture-based system, such as in Ireland, Australia and New Zealand, is critical, together with the development and use of information and communications technology (ICT) within pasture management. In general, it has the potential to signifiantly increase the efficiency and sustainability of milk production, where information can be immediately turned into management action. This is the goal with regard to ICT within pasture management, and the research being conducted in this area. In rotational paddock-grazing systems, cows are allocated grass within a pre-defined area. With virtual fencing technology, there is no perimeter wire, rather GPS localisation, wireless networking and motion planning are combined to delineate the boundary. A key element is real-time location and the motion control of animals, thus allowing pro-active management and the control of a dynamic boundary. Virtual fencing has the potential to take the concept of precision feeding to a new level and towards individual animal allocation of a grazing area.

Questions addressed by the project:

- Development of an ICT based tool with GPS technology capable of mapping farms and that can capture relevant grass measurement parameters (e.g. pre- and post-grazing herbage mass) automatically;
- Testing and validation of the developed ICT tool on research and pilot farms in France, Ireland and Switzerland
- Integration of data from the ICT tool with an existing web-based decision support tool "PastureBase-Ireland" (PBI) to interpret data generated and produce simple grassland management reports on research farms in Ireland
- Investigation of the feasibility of 'Virtual Fence' technology for use in intensive grazing systems

3. The experimental studies:

During the Irish grass growing season of 2014, the automated grass measurement prototype tool underwent a number of calibration stages. Initially grass measurements made by this tool and the Jenquip (platemeter) were compared. The instrument was subsequently modified such that the tool was attached to the Jenquip. This allowed measurements to be obtained from the manual Jenquip reader and the automated digital device, on the same grass height sample. Subsequently, operating procedure of the automated grass measurement tool was modified to ensure that it was always reading 'Zero' pre-measurement. The automated digital device and Jenquip were then tested by using them to measure 32 pipes cut to different heights. The automated digital device and Jenquip were similar in accuracy, with the automated device measurements numerically closer to the actual pipe heights. Developed algorithms allowed various data calculations to determine grass cover. The algorithms were subsequently refined to take account of seasonal variation and grass type (ryegrass/clover mix). The automated device measurements and calibration were also carried out in France. During the 2015 season, the automated device was made compatible with the Decision Support Tool 'PasturebaseIreland'. Thus the data from the automated device can be uploaded directly to PBI which is used for management decisions on whole farm grassland and grazing management.
The main components of the Virtual Fence System included: *Collars* worn by each participating cow; *Radio Networks* consisting of a control station from where commands are sent to each cow individually or globally to all cows in the trial; *GPS Reference Station* located at the site office used to generate corrections for use by the collar mounted GPS units; *Monitoring and Control Station* consisting of a PC running software to

transmit commands to the cows and to monitor all radio traffic to and from each cow. Implementation: The basic radio control networks were brought on-line and trials were commenced to determine the optimum warning and stimulus levels. Following these trials it was decided to add a tactile element in order to eliminate possible problems which may arise from sonic warnings issued to a neighbouring cow. The collar control units were revised to incorporate this tactile element. An Android app was developed to run on a tablet used by an operator in the paddock to send commands during the initial cow 'training' period. The tablet communicated with the cow through a mobile CH3 transmitter. Following a series of tests during which numerous iterations of the collar and stimulus levels were tested, a final design was agreed as a collar with adjustable dimensions between 70 and 115cms and a single stimulus level. Collars were then delivered to the site for trial in a herd setting. Protocols have been developed for training of cows to use the virtual fence.

4. Main results:

- An automated grass measurement system was developed with the following concept and design features: (1) The grass measurement tool or rising plate meter connects to a satellite via GPS and the location of the tool is then recorded on a smart phone. The smart phone also has a package through which a paddock and farm map can be constructed for future use. (2) Prior to grass measurement, using a smartphone application developed specifically for the tool, the operator pre-selects the paddock area to be measured and inputs other data required to complement the grass measurements performed by the rising grass plate meter, so as to calculate the herbage mass. (3) Grass-height measurements are then taken by the automated tool. (4) The data are then transferred via Bluetooth from the tool to the smartphone application and the operator is informed of the grass height, herbage mass and where to place the fencing wire within the paddock to achieve an accurate grazing allocation.
- A new form of virtual fence technology was developed and manufactured for testing within an intensive grazing situation. It focuses on controlling animal location and therefore, precise feeding. It uses GPS to automate the generation of stimuli at the appropriate location. The sensory cues were developed and tested in an attempt to ensure that they elicit consistent cow behaviour in response to GPS coordinates, effectively creating an invisible fence line (and thereby control of the animals).

- **Opportunity/Benefit:**
- Demonstrated the possibility for automated routine grass measurement and highlighted the advantages of having accurate grass yield data to make accurate grazing management decisions
- Assisted in increasing the uptake of PastureBaseIreland.
- Increased the possibilities for increased farm profitability through using accurate, real time data in grassland management decisions
- Progressed the testing and modification of the principle of VF technology

5. Dissemination:

Main publications:

French, P., O'Brien, B.and Shalloo, L. 2015. Development and adoption of new technologies to increase the efficiency and sustainability of pasture-based systems. *Animal Production Science,* 55(7): 931-935.
O'Brien, B. and Upton, J. 2013. Combining automatic milking and precision grazing on dairy farm systems. Precision Livestock Farming '13. Papers presented at the 6th European Conference on precision Livestock farming. Leuven, Belgium, 10-12th September, 2013. Pages 217-222.
Mcsweeney, D., Foley, C., Umstatter, C., Halton, P. and O'Brien, B. 2014. Novel concept to allow automation of grazing management within a dairy farm system. In: Proceedings of International Conference of Agricultural Engineering. Held at ETH, Zurich. 6-10th July, 2014. www.eurageng.eu Ref: C0379.

Popular publications:

McSweeney D., Foley. C., Halton P. and O'Brien B.(2015). Calibration of an automated grass measurement tool to enhance the precision of grass utilization and allocation in pasture based farming systems. In: Proceedings of the 18th Symposium of the European Grassland Federation. 'Grassland and forages in high output dairy farming systems'. Grassland Science in Europe, NL, 15-17 June. Volume 20: 265-267.
O'Brien, B. and McSweeney, D. (2015). Grass measurement breakthrough. *Today's Farm*, 26(5):6-8.
O'Brien, B. 2014. Robotics Business Review Series – Big Ag and Agribotics. Webcast https://event.webcasts.com/viewer/event.jsp?ei=1034586 Thursday May 29th 2014.

6. Compiled by: Dr. Bernadette O'Brien

Contact Email: john.mee@teagasc.ie