RESEARCH & DEVELOPMENT

QMS

2012/13 EDITION

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Contents

Introduction

Professor Phil Thomas

Chairman, Research & Development Committee, QMS

The long-term indications are that Scotland, along with the rest of the UK and many other parts of the world, is facing a period of disrupted weather patterns. As the terminology 'climate change' has progressively replaced that of 'global warming', farmers are beginning to understand what the long-term implications of climate change might mean.

The QMS Research & Development (R&D) committee has been undertaking the same kinds of considerations for some time. It is not possible to change the weather. However, it is possible to focus R&D on topics related to climate-influenced diseases and poor stock performance. These may result from unusually wet and cold or unusually hot and dry weather – and some Scottish areas have experienced both this year.

Almost by definition, R&D is a long-term process: the more you learn the more you recognise the limits of your knowledge. However, as a matter of policy QMS seeks to accelerate the translation of research findings into practice and, where possible, relevant on-farm technology. The Monitor Farms, Focus Farms and Business Improvement Groups play an important part in dissemination. But R&D impact is also created at the individual farm level through the farmer being able to align a recognised problem with a perceived R&D-based solution.

This past year we have continued to pursue that objective through information access via the media, the QMS website and the QMS R&D Conference. But we also engaged in a new initiative designed to optimise the farmer-to-scientist information flow. As a pilot, we assembled a group of leading researchers and a panel of farmer-speakers and provided the forum for the farmers to tell the scientists what they wanted from R&D. This proved a significant success and also provided the R&D committee (of mainly farmers and processors) with reassurance on our direction of travel.

As always, this annual R&D report provides only a snapshot of ongoing work. However, I hope you find it interesting and informative, and I thank the many people whose R&D efforts continue to contribute to our industry's resilience and future.

QMS Research & Development Strategy
2010 – 2013

Background

Research and Development (R&D) is a core activity within the overall strategy of Quality Meat Scotland (QMS). The focus of the QMS R&D strategy is to provide the basis for efficiency, profitability and sustainability benefits to Scottish farmers and processors of red meat animals. In 2008 QMS became a non-departmental public body of Scottish Government and, where appropriate, the QMS R&D strategy also addresses some of the high level objectives and national outcomes of the Scottish Government.

The overall strategy of QMS is:

To shape a sustainable and prospering Scottish red meat industry.

QMS will achieve the overall strategy by:

1. Working with the industry to develop and build markets;

2. Increasing the uptake of proven solutions to improve industry efficiencies;

3. Assisting the industry to inform consumers and satisfy customer expectations;

Creating confidence which promotes industry investment in its future;

4. Promoting economic and environmental sustainability;

5. Developing partnerships and where relevant leveraging additional resources.

The following strategy outlines the QMS R&D objectives and deliverables for the beef and lamb sectors for the three years (2010-2013). Specific R&D for the pig industry will be covered by the QMS Pig Forum.

1. R&D Aim

To underpin improvements in the efficiency, profitability and sustainability of Scottish livestock farms and abattoirs

QMS aims to achieve this by:

- Maintaining QMS as the first port of call for the red meat industry for information in science and technology;

- Providing information and translation of the science to support the implementation of best practice;

- Enabling industry innovation through research and technology transfer;

Market stability - local and global

Environmental change

Food security

Skills and manpower

Innovation and scientific excellence

Profitability and Efficiency of Production and Processing

- In animals: genetics, health and disease, nutrition
- On farms: husbandry, welfare, resource management
- In processing: carcase use, resource management

Best practice

Product Quality and Support for Building Markets

- Supply chain innovation and information
- Carcase and meat quality measurement
- Innovations through butchery

Economic benefits through practical uptake of results

The diagram illustrates our objectives and the factors that will influence our decisions.

2. Objectives

We have identified research needs under three strategic objectives:

- Improved profitability and efficiencies in production and processing systems;
- Improved quality and marketability of the product;
- Improved communication of research and development results.

3. Challenges & Opportunities

Before addressing each objective, it is important to acknowledge the challenges that the Scottish industry will face in delivering on each one. We see these challenges as:

- Many determinants of meat quality remain unidentified;
- Margins in production and processing are already very tight;
- Level of disease is not sufficiently quantified and disease prediction is difficult, particularly in a changing environment;
- Improvements to meat quality and animal health/welfare must be delivered but in a cost effective manner;
- The diversified nature of the Scottish farming industry means that no single solution fits all;
- There is a shrinking research base and budget in the UK;
- There is a need to adapt to and mitigate the effects of changes in the environment;
- Changes in legislation will continue to occur.

Equally, there are many opportunities for the red meat industry to combine in tackling the problem of improving the lot of producers and processors, as well as increasing the consumption of the product.

4. Delivering the objectives

Each objective listed above has been broken down into priority areas in which QMS will seek to meet the objective by commissioning research, carrying out rapid-answer trials, or simply through making the relevant information available to the industry.

4.1 Improved profitability and efficiencies in production and processing systems

- Take initiatives to foster best practice in beef and lamb production which examine the fixed and variable costs in keeping with current and likely future statutory requirements;
- Explore means to optimise resource and land management in various production systems;
- Development of health and welfare improvement systems, including diagnostic tools for priority diseases;
- Focus on ensuring sustainability of forage-based livestock production systems;

- Explore potential for use of appropriate feeds and feeding regimes to reduce costs of production whilst maintaining or improving meat quality and reducing environmental impact;
- Develop further the use of livestock genetics to improve production, reduce waste and increase profitability: Scottish genetic resources will be considered in all projects where appropriate;
- Evaluate environmental profile of Scottish production systems for beef and lamb, with particular emphasis on carbon and energy.

4.2 Improved quality and marketability of the product

- Develop and implement methods for integrated and/or automated measurement of carcase and meat quality;
- Explore and develop opportunities for improving value from innovative use of the whole animal;
- Further develop and consider implementation of technology to determine the origin of red meat and to identify and reduce mislabelling of Scottish product;
- Monitor eating quality of product to the point of sale;
- Identify points of difference or unique selling points for Scottish products;
- Explore and develop technological advances in processing and product safety;
- Develop opportunities for improved information flow in the supply chain.

4.3 Improved whole chain communication of research and development results and knowledge exchange

An important part of this strategy will be exchanging knowledge with and communicating the research and development results to industry, in particular, levy payers from the production and processing sectors. QMS will endeavour to develop more channels for disseminating the information from various projects to the industry. Previous approaches have tended to focus on Knowledge Transfer (KT) which tends to be a one way process outward. Experience from the Monitor Farm programmes has highlighted the importance of Knowledge Exchange (KE), a two way process. Greater emphasis will now be placed on KE than in previous strategies.

The main components in the Knowledge Exchange programme across the whole chain will be:

- Regularly produced press releases and information articles;
- Enhanced use of the QMS website;
- Regular QMS email newsletters;
- QMS attendance at shows/sales and other industry events;
- Greater use of the Monitor and Focus Farms Programmes;

- New network events with active research scientists;
- Structured meetings with producers, including the Business Improvement Groups;
- The R&D Report, technical leaflets and booklets;
- Theme-focused R&D conferences.

In addition, KE will also occur through field days, meetings or demonstration rollouts of new technology. This requirement will either be built into funded projects, where relevant, and possible or met through in-house activities such as the production of DVDs, CDs etc. Where appropriate, field days will be arranged in partnership with other organisations with experience in KE such as NFUS, NSA and SBA. When a project has been completed in partnership with another organisation, we will always look to use their established routes of communication to the industry, but with QMS funding recognised.

5. Measuring success

The success of QMS R&D will be determined by the combination of a number of factors. These will principally include the number of projects commissioned; the number completed successfully; the level of relevant information disseminated; and ultimately evidence of funded work being taken up by the industry.

The R&D committee will monitor commercial uptake of any new ideas or technology arising out of QMS-funded work. Encouraging implementation of proven new technology or established best practice will be a priority for QMS. Formal evaluation of events and projects will be undertaken via feedback forms or external assessment, as appropriate.

6. Role of the Research and Development Committee

The R&D committee is responsible for advising on, approving and directing the R&D activities of QMS for the beef and lamb sectors. The committee comprises farmers, processors, Scottish Government Rural Directorate, QMS and is chaired by a member of the QMS Board.

7. Relationship with other bodies in the UK

The R&D committee will be linked to the other levy bodies, specifically HCC, Agrisearch and EBLEX via the Devolved Bodies R&D committee. This committee is made up of executive personnel from each red meat levy body in the UK and meets every six weeks. Funding for potential joint projects is discussed within this committee.

QMS is also a member of the CAMERAS Board (Coordinated Agenda for Marine Environmental and Rural Affairs Science) which has been set up to ensure that the science resources falling within its ambit address the policies and priorities of the Scottish Government in an efficient and effective manner.

8. Funding

In addition to its direct use of levy income, the R&D strategy aims to add value to the R&D programme by building partnerships, where appropriate, by seeking additional sources of R&D investment or in kind support. Thus QMS may fully fund projects, provide joint funding or work in support of projects meeting the R&D strategy of QMS. This may include partnership working with Scottish Government and members of the Scottish Government R&D family through CAMERAS; Scottish Enterprise, HCC, EBLEX, Agrisearch, DairyCo, EU, Biotechnology & Biological Sciences Research Council (BBSRC), Supply Chain Partners, Funding Councils and industry organisations.

9. Procedure for handling a funding application

QMS provides funding for research through various routes which include grant-in-aid, collaborative proposals (including studentships) and following a call for research applications. All proposals will be considered by the R&D committee, which will make the final selection decisions. Proposals may also be subjected to peer review, where appropriate. Further information can be obtained by contacting QMS at info@qmscotland.co.uk. No unsolicited applications for QMS research funding will be accepted.

From time to time QMS also issues tenders for R&D projects. These are dealt with according to Scottish Government procurement procedures and can be found advertised on the QMS website at www.qmscotland.co.uk

Collaborative funding

QMS is keen to be involved in collaborative proposals; programmes of work in which QMS is a partner and shares the cost with other funders. Collaborative proposals may be initiated by QMS, other funders, research organisations or businesses. Ideas or applications for partnership or development proposals involving partners can be submitted at any time. These proposals will be considered by the R&D committee and may be subjected to external peer review either via QMS or through the other collaborating funders.

Appendix

Acronyms

BBSRC, Biotechnology & Biological Sciences Research Council

CAMERAS, Coordinated Agenda for Marine Environmental and Rural Affairs Science

CNPA, Cairngorms National Park Authority

Defra, Department of Environment, Food and Rural Affairs

EBLEX, English Beef and Lamb Executive

EU, European Union

HCC, Hybu Cig Cymru – Meat Promotion Wales

HGCA, Home Grown Cereals Authority

KT, Knowledge Transfer

KE, Knowledge Exchange

NBA, National Beef Association

NFUS, National Farmers Union Scotland

NSA, National Sheep Association

PCHS, Premium Cattle Health Scheme

R&D, Research and Development

SBA, Scottish Beef Association

SOPA, Scottish Organic Producers Association

SRDP, Scotland Rural Development Programme

SRUC, Scotland's Rural College

PROJECTS

PARABAN – knowledge exchange for the control of Johne's Disease

Institute: Consortium led by Scotland's Rural College (SRUC)

Principal Investigator: George Gunn

Status: Ongoing

The problem

Paratuberculosis can be a very frustrating disease for farmers and vets. The disease (also known as Johne's) is an insidious disease caused by the bacterium Mycobacterium avium ssp. paratuberculosis (MAP). Clinical disease (Johne's disease) results in a thickened small intestine, diarrhoea and chronic wasting eventually resulting in death. Subclinical disease can result in poor performance. As such the disease is of considerable economic impact to Scottish industry. On-farm control is difficult due to its long incubation period and because the disease is frequently spread by subclinically infected animals. Control of Johne's disease is best achieved by the early removal of infected animals from the herd to prevent further spread. However, particularly in the early stages of the disease the infection is able to evade the infected animal's immune response, thus it can be difficult for diagnostic tests to detect. Cases that weren't detectable by earlier tests then become detectable as the disease course progresses. Because of this, infected animals may still be being detected in the herd later on after years of implementation of interventions at considerable expense and effort by the farmer. A long term approach and perseverance is needed on farms. Working out a long term plan is essential between farmers and vets and involvement of health schemes is beneficial in this process.

The Project

PARABAN is a project using knowledge exchange to identify feasible best practices for the monitoring and control of paratuberculosis (Johne's disease) on Scottish farms. Nine 'Champion Farmers' with their vets are being followed over the course of three years. Each farm is very different, so that there is a breadth of farm types and disease levels represented. Each farm is, in effect, a case study.

The aim is to break down some of the barriers to disease control among which are a lack of awareness and understanding of the disease, a perception that expectations for control are unrealistic or not cost effective, or that control attempts are futile. The project has established an effective communication network between our study farms, their vets, health schemes, members of the industry, and scientists to identify the best testing and management options for the control of paratuberculosis on a farm by farm basis (Figure 1).

This network has enabled the best available knowledge from those involved in paratuberculosis control, from farmer and vet to scientists and industry, to be utilised in a realistic and effective manner, while workable solutions may be tried and monitored for each farm. Ultimately, if this sort of approach of engagement of all stakeholders proves successful, it could be implemented in other disease control initiatives. It is a three year project funded by the Scottish Funding Council in conjunction with Scottish Government and QMS. It is led by the Epidemiology Research Unit (SRUC research) in Inverness with project partners from the Universities of Glasgow and Edinburgh and the James Hutton Institute.

Figure 1 Knowledge exchange framework
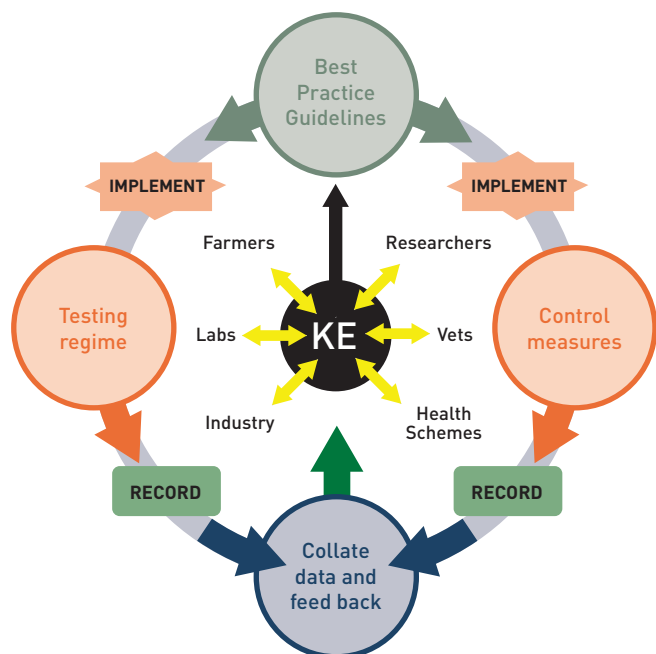
There is also a programme of communication to wider farming community and stakeholders. KE materials to the wider farming community consist of Open Days, leaflets, a short Youtube film (in progress) and a web page (in progress). KE within the team (comprised of the project partners, PARABAN farmers and vets and other stakeholders) consists of a combination of field team meetings, steering group meetings, results summaries and bulletins. Throughout the project the knowledge exchange process is monitored by gaining feedback from those involved and the flow of information is improved.

Building a picture for each farm

A picture of paratuberculosis infection is being built for each farm by monitoring the levels of infection via a combination of live animal testing (blood testing, and milk testing for dairy farms, with the option of faeces testing as needed), abattoir testing and environmental testing. These results are helping to further our understanding of, not just the disease itself, but also under what environmental conditions the bacteria survives outside the animal.

Live animal test and control strategies

The project is currently investigating the benefits of more frequent testing and the inclusion of slightly younger animals in the herd screen to identify those relatively few animals that are seroconverting younger. The aim is to identify what combination of blood, faecal and milk testing of live animals provides the best basis for decision-making by asking the question:

What are the most effective and feasible control strategies for each farm?

This main question is addressed by considering a range of options:

Cull positives?

Isolate then cull?

Isolate and re-test?

Isolate and manage?

For each farm, these options are discussed to establish the best way to manage the infection in the herd. The feasibility of the implementation of best practice advice with respect to live animal testing and control is assessed by all involved in the chain from farm to research (farmers, vets, health scheme providers, laboratories, researchers and recognised experts). Decisions are ultimately made by the farmer and their vet and interventions implemented whilst the prevalence of paratuberculosis on the farms is monitored.

Abattoir sampling

As part of the PARABAN project the 'Champion Farmers' have been allowing, whenever possible, samples to be taken from all adult animals leaving their farms for culling – whether or not the animals had tested positive for Johne's disease on blood, faeces or milk tests. This is adding to the picture of the disease status on each farm and was intended to assess the feasibility of this method in monitoring Johne's in pre-clinical animals. With co-operation from the abattoirs a sample from each animal has been taken of the area of intestine shown to be most commonly affected in work done with clinical cases. These are then available for histopathological examination and a tissue archive is being held in freezers.

Environmental sampling

Environmental sampling of farms is increasing understanding of the long-term on farm control and improving knowledge of the environmental stability of MAP. On some farms, control measures such as best practice and health schemes have been successful in controlling Johne's. However, these control measures do not seem to work on all farms. The live animal testing undertaken within the PARABAN project has investigated areas of uncertainty within the testing regime itself. However, uncertainties still remain and this suggests there may be other, unrecognised factor(s) associated with disease prevalence. There is an increasing body of evidence to suggest that environmental factors, such as soil characteristics, play a role. The scientific literature suggests that important factors related to increased prevalence of the disease include cool, wet climate, low soil pH, high available iron, and high soil organic content.

Most of the evidence on environmental factors for Johne's disease comes from the United States and Australia. There is very little Scotland-specific data on environmental risk factors for Johne's disease. For these reasons, the PARABAN project has collected new data through a combination of environmental sampling and structured interviews with farmers.

Results to date:

Live animal testing and control strategies

All farmers have implemented test and management strategies that have been adapted for that farm. An overall trend of falling prevalence of animals testing positive for infection has been observed across every herd (Figure 2). For those farms for which there are data extending from before the start of the PARABAN project, a longer term dataset has been included. It is notable that the majority of the farms have adopted a more than once annual testing regime including younger animals; twice yearly whole herd screening of all breeding animals over one year of age, with isolation and prompt cull of infected animals. This indicates a willingness to test when the cost of testing is not an issue (the PARABAN project covers testing costs). Twice yearly testing and removal of all animals with positive antibody titres has not been feasible on all farms, however. A realistic strategy has been imposed for each farm and other measures to manage the disease have still been implemented, such as rigorous attention to calving hygiene, thus benefits have still been observed. To date there are approximately 12,000 results for serum, faeces and bulk milk samples across the nine farms.

On one farm once yearly testing of all animals over two years of age (rather than twice yearly testing of all animals under two years of age) was adopted as the most feasible testing strategy. Another farm had previously implemented vaccination which ceased two years before they joined the PARABAN project. Thus, for this farm, high antibody titres in animals may be attributable to vaccination rather than infection. Because of the high prevalence of animals with elevated titres in this dairy herd and because it is not possible to distinguish between true infection and vaccination, isolation and culling strategies are less rigorously employed lest non-infected cows be culled, thus slower progress has been observed. A third farm was not

able to cull out infected animals due to a fertility issue on the farm which necessitated retention of breeding females. Whatever the farm situation, the formulation and implementation of workable measures for that farm have still allowed a handle on the disease to be retained, albeit with apparent slower progress than the other farms. However, due to the chronic nature of the disease course and the long incubation period following infection, further monitoring of these farms is warranted for longer term validation of these observed short term effects.

Figure 2. Time trend of animals testing positive or inconclusive on each farm following the implementation of a test and control plan.

Beef farm 1

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive
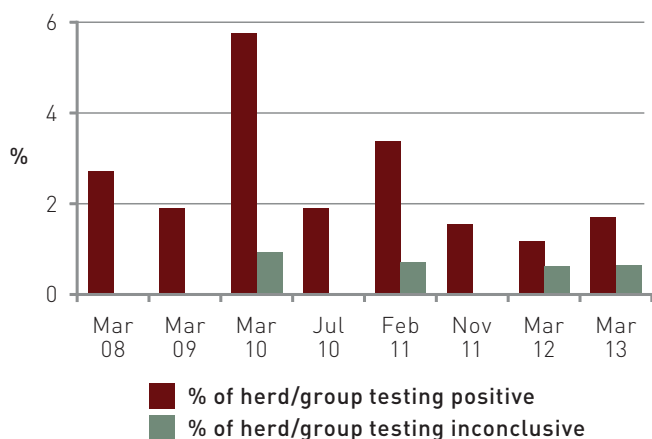
Farm background and approach

• 180 head pedigree beef suckler herd.

• Initially once yearly blood testing, twice yearly blood testing has been implemented over the last few years, although this was not feasible this last year.

• Blood test positive and inconclusive cows are managed completely separately and culled after calves are reared.

• Careful attention has been paid to management of grazing areas to try to prevent animals grazing in fields where infected animals may have previously contaminated the environment.

Beef farm 2

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive
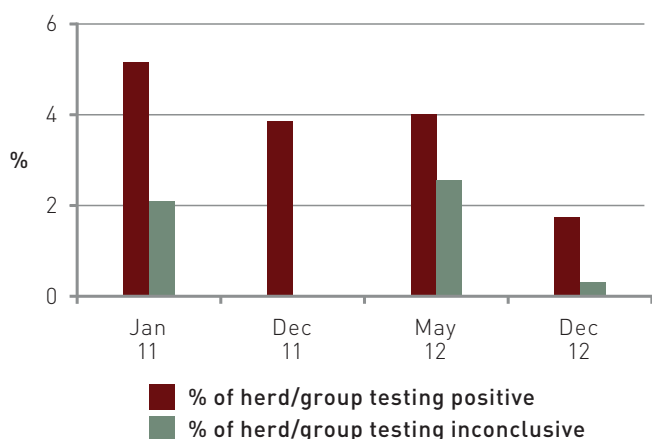
Farm background and approach

• A 300 head beef suckler herd.

• Has only been testing relatively recently but has seen fairly rapid benefits from twice yearly testing.

• Blood test positive cows are managed separately and culled soon after weaning.

Beef farm 3

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive
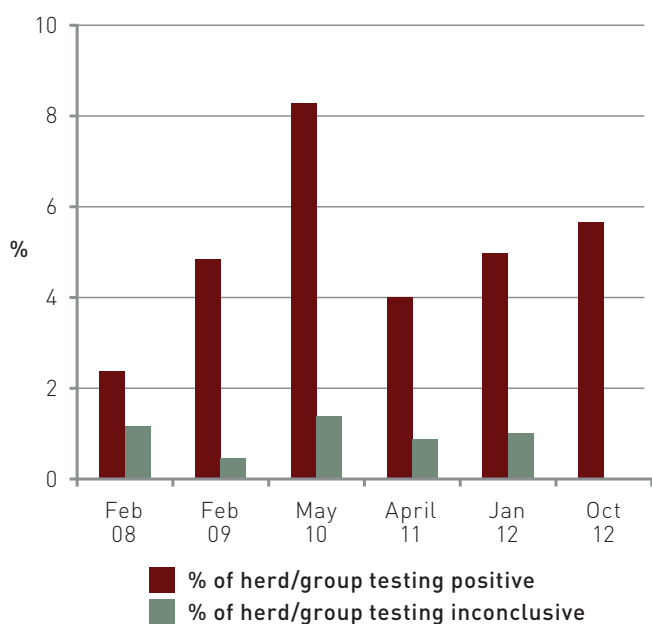
Farm background and approach

• 240 head beef suckler herd.

• Buys in replacements from accredited sources.

• Initially once yearly blood testing of whole herd.

• Testing frequency has increased over the last two years.

• Progress has been hampered by a fertility problem on the farm which necessitated retention of non-clinical blood test positive cows in the herd.

• With conception levels back to normal this year, it is envisaged that the earlier trend of decrease seroprevalence will be observed as seropositive animals will be removed from the herd once again.

Beef farm 4

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive
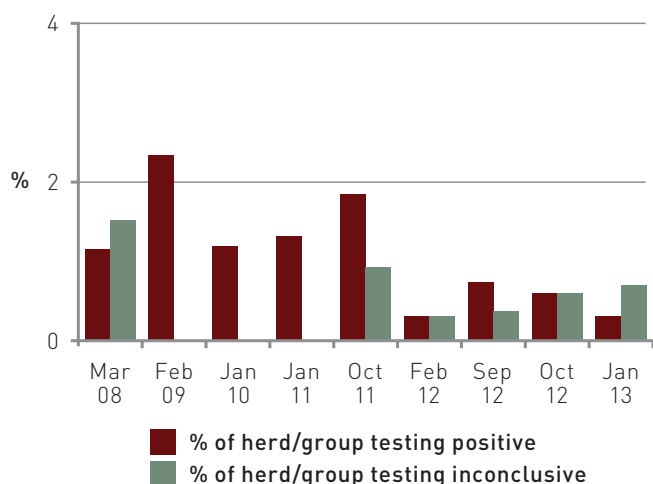
Farm background and approach

- A 300 head suckler herd with a low seroprevalence of paratuberculosis, now twice yearly blood testing, but in batches in 2012.

- This farm removes blood test positive animals from the herd as well as the daughters of these animals to try and minimise the risk of silently infected cows remaining in the herd.

- A sustained effort to eliminate paratuberculosis from the herd has seen the levels drop to almost zero with only one cow testing positive and a "low" positive at that. The farmer has concluded that sustained management of the disease to achieve almost zero levels is more realistic than outright eradication.

Beef farm 5

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive

Farm background and approach

- A 180 head beef suckler herd.

- Blood positive cows are isolated from the rest of the herd before calving, and are culled after their calves are weaned. These calves are not retained as replacement heifers.

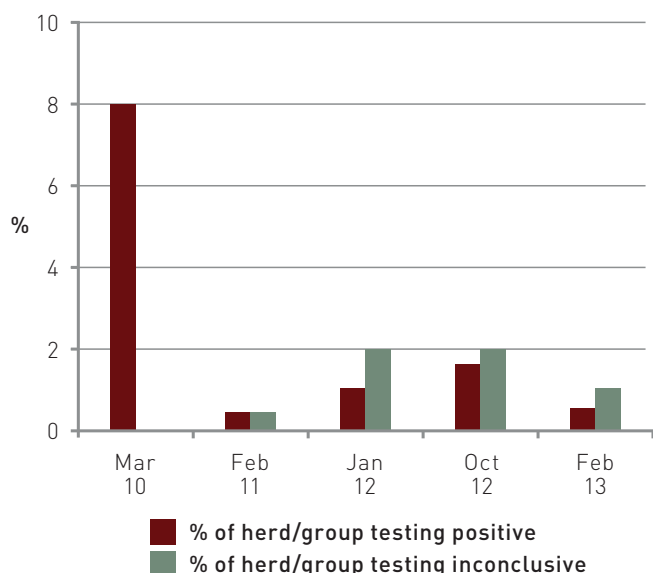- Bought-in cows are tested for Johne's before mixing with the herd. The importance of this was illustrated recently when a batch of bought-in in-calf heifers tested positive and were therefore identified and not permitted to mix with the herd, thus avoiding a potential disaster.

- Seroprevalence has decreased overall over the last three years with a low seroprevalence now observed.

Beef farm 6

Blood test results

% of herd/group testing positive
% of herd/group testing inconclusive
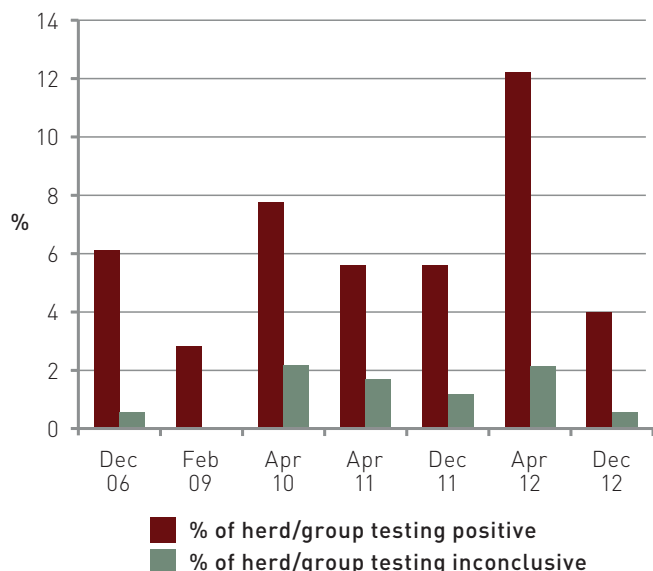
Farm background and approach

- A 180 head beef suckler herd that has a long history of testing for paratuberculosis.

- They have been testing twice yearly for two years.

- An unexplained spike in test positives observed in April 2012 is confusing as there was otherwise a clear trend of decreasing seroprevalence since 2010. However the latest results indicate that seroprevalence is still decreasing and the next test should provide more information on the long term trend for this farm.

- Test positive animals are housed and managed separately from the rest of the herd. Bought-in replacements are from Johne's free herds.

Dairy farm 1

Blood test results

■ % of herd/group testing positive   ■ % of herd/group testing inconclusive
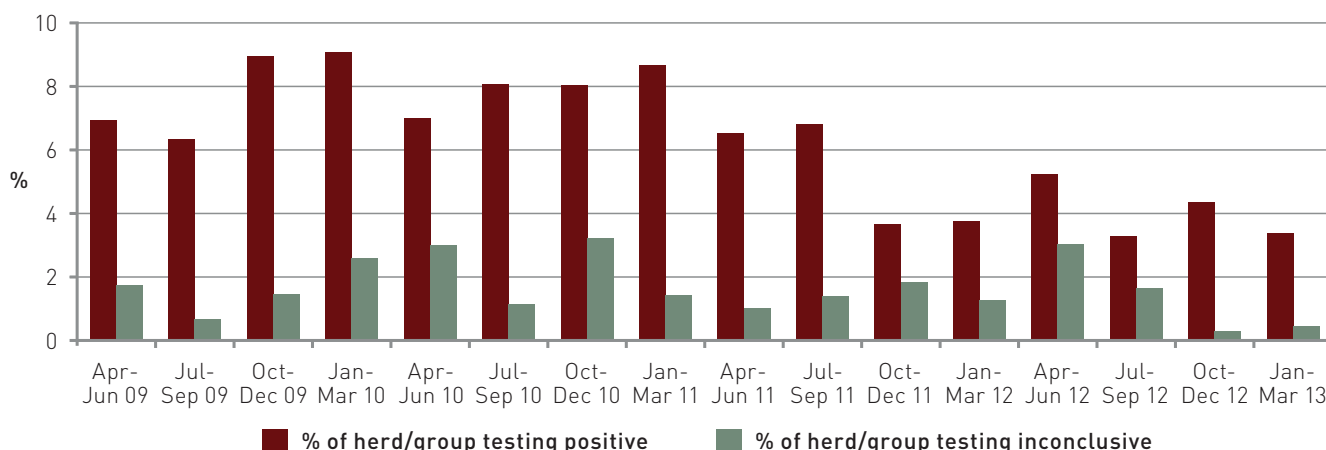
Farm background and approach

- A 340 dairy herd with twice yearly blood testing (at dry-off as well as once year whole herd test) and quarterly milk screening.

- Vaccination was previously used until 2008, which has resulted in high seroprevalence as vaccinated cows have high antibody titres.

- However, true levels of infection in the herd cows is thought to be lower. Blood and milk test history used to categorise cows into a risk category.

- Test positive cows thought to be genuinely infected are calved separately. All heifers are also kept separate. Calving hygiene is important and calves born to seropositive cows are caught at birth where possible. However if a calf is missed and suckles from an infected dam, that heifer is not retained for breeding.

- Decrease in seroprevalence has been observed even when accounting for fewer vaccinated animals in the herd.

Dairy farm 2

Blood test results

■ % of herd/group testing positive
■ % of herd/group testing inconclusive
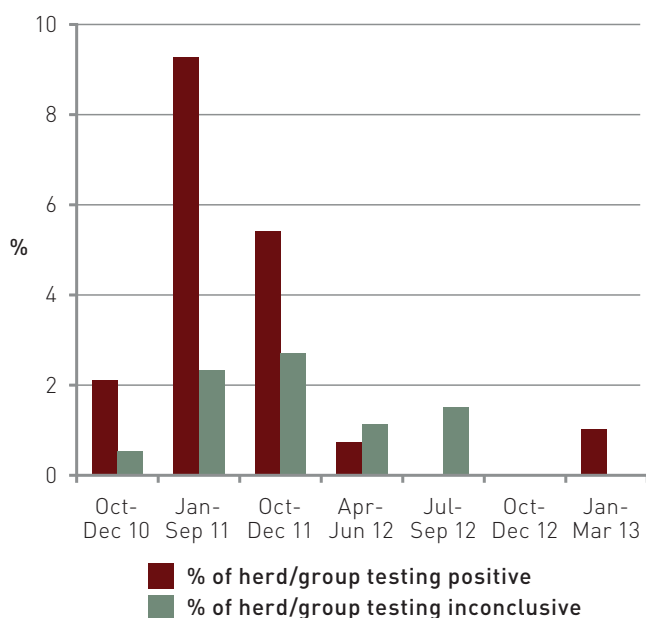
Farm background and approach

- A 170 head organic dairy herd, now twice yearly blood testing and quarterly milk screening. Faecal screening has also been used.

- A risk based approach is employed using a combination of milk and blood results and also faecal testing. Cows are assigned to a risk category according to their test history and high risk cows are removed from the herd after that lactation.

- Meticulous attention to tracing back maternal lines means that the farmer is aware of which cows may potentially pose a higher risk later on. As it is an organic farm, the calves must stay with their mothers and suckle for the first three days. However, heifer calves from test positive cows are not retained in the herd as replacements.

- This farm has achieved an impressive decrease in seroprevalence over the last two years.

Dairy farm 3

Blood test results

Feb 10, Mar 11, Mar 12, Mar 13

- % of herd/group testing positive
- % of herd/group testing inconclusive
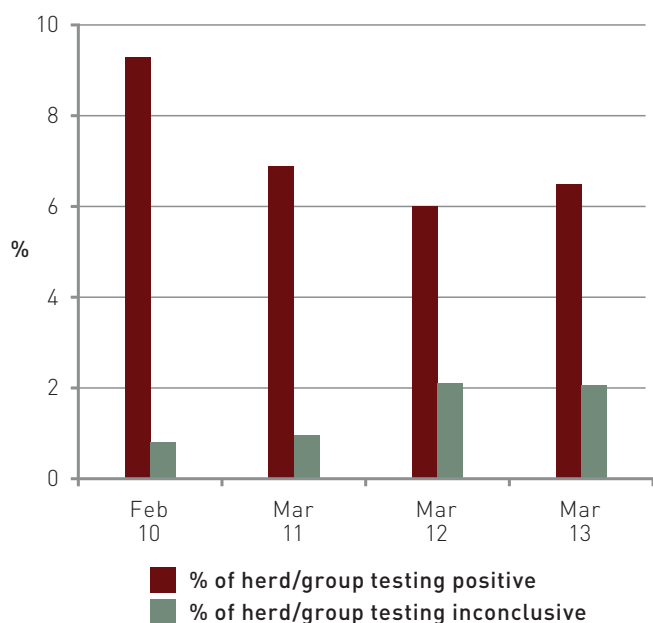
Farm background and approach

- A 1200 head dairy herd, once yearly blood testing and quarterly milk screening.
- Bought in Johne's after 2001 FMD restocking.
- Focusses on calving hygiene and not feeding milk or colostrum from blood test positive cows.
- Calves are caught at birth but maternal bond retained by specially designed calving pens allowing calf to be licked by cow.
- Colostrum is fed only from test negative cows and cow's milk pasteurised individually and fed to her own calf until weaning. Colostrum and milk from positive cows is not fed to calves.
- Risk based ear-tag system employed based on cow's blood and milk test history and cows culled out when in very high risk category.

Abattoir sampling

Results from the 2011-2012 sampling season have suggested that it is possible to confirm the presence of MAP within six of the eight herds which provided subjects. However the level of agreement between the live animal tests as reported by the farmers and the results on histopathology was only "fair" when taking each individual case (Figure 3). Although this may be partly due to the low rate of detection that could be expected from the method, it has been encouraging that nearly 90% of animals shown to be positive on histopathology had a positive blood test result. With results still pending from the 2012-2013 season it may be possible to make further assessments of this method as part of monitoring disease in pre-clinical animals. Without a doubt this part of the study is emphasising the difficulty in getting a clear picture of the disease with regard to the individual animal.

Figure 3. Histopathology and blood test results of animals sampled at the abattoir

		Evidence of Johne's Disease on histopathology			
		Positive	Suspicious	Negative	Total
Serum ELISA result	Positive	15	4	28	47
	Negative	2	7	109	118
	Total	17	11	137	165

Environmental sampling

Information of environmental attributes of the soil and climate may be of use in informing farmers on risk based decisions for farm land management with respect to grazing. Soil and water samples have been taken from eight farms covering a range of Scottish cattle farming ecotypes (from Dumfries and Galloway in the South West through to Caithness in the North East). The MAP bacterium that causes Johne's disease is very small in comparison to the farm environment, so finding it somewhere on the farm is problematic. Due to this we devised a risk-based approach to sampling the soil and water environment (Figure 4). Sampling locations were selected through a combination of soils data and through speaking with the farmers to understand how different fields have been managed. Samples were taken from potential MAP 'hotspots' where we would expect the organism to survive best; and also from areas where we would not expect to find the organism. At each sampling location, a series of individual soil samples were taken orientated on a feature such as a hay ring or trough. Any associated water samples were also taken.

Figure 4. Sampling framework – four sampling locations on each farm based on expected MAP presence

Expected MAP presence potential according to…	
Environmental/soil parameters	Farming/livestock activity
HIGH	HIGH
HIGH	LOW
LOW	HIGH
LOW	LOW

Soil samples have undergone physicochemical characterisation to determine characteristics such as pH, organic matter content and available iron, as well as pore water analysis for a further 18 chemical elements. Soil and water samples have also undergone DNA extraction to detect and identify the organism using molecular techniques. As with any DNA-based method, it is difficult to know if the final measurements reflect viable or dead organisms. As one aim was to identify locations where the bacteria were living and have the potential to re-infect cattle, a specific chemical (EMA, ethidium monoadize) was added to the samples which binds to 'naked' or partially degraded DNA and prevents the machine from measuring them. This means that all the results reflect potentially viable MAP bacteria.

Overall 192 soil sub-samples, and 22 water samples were analysed for presence of MAP; 75% of farms tested positive for the organism (Figure 5). In all cases, samples that tested positive were from locations where we expected to find the organism.

Figure 5. Overall results of DNA extraction and analysis

- No MAP detected
- MAP detected
- Borderline MAP detection

The work has demonstrated that MAP survives best in low pH soils with high availability of iron, in a cool and moist climate.

Conclusions to date

Live animal testing

Testing strategies and control strategies work well; a decrease in the proportion of animals testing positive for infection has been observed across all farms. Each farmer has adopted a long term flexible strategy that is suitable for their needs in discussion with their vet. Every farm is different so for some farms, progress may be more gradual, which is to be expected when dealing with a disease with such a long incubation period and chronic time course. Farmers should have an initial testing strategy to determine prevalence. However, the early strategy may change later depending on progress and other situations on farm. Decisions regarding test frequency, culling of positives and management of infected stock will depend not only on prevalence results but other factors relating to finances, facilities for isolation of stock and realistic goals for level of control on the farm.

Abattoir sampling

Abattoir sampling can be a means to support and supplement decision making at herd level as part of a MAP control plan. It may be possible to use post-mortem sampling to estimate the prevalence of infected animals. However this method requires a great deal of co-operation from farmers and slaughterhouses and has financial constraints.

Environmental sampling

After management, environment may play a significant role in disease prevalence with 75% of PARABAN farms testing positive for MAP. It is probable that the organism can survive for longer in acidic soils rich in organic matter and available iron. MAP was detected where either farming activities or soil factors suggested high likelihood – but not necessarily where both coincided. JHI soil geochemical data can be used to make a reasonable prediction of where the organism is likely to survive the longest.

An investigation into the use of video image analysis (VIA) and visible near infrared (NIR) spectroscopy for carcase evaluation

Institutes: Massey University and Scotland's Rural College (SRUC)

Principal Investigator: Cameron Craigie

Status: Completed

The problem

Meat producers and processors aim to supply meat to consumers. Therefore it is important that consumer preferences are conveyed along the value chain so supply can be optimised to meet demand. Carcase evaluation is undertaken to determine the value per kilogramme of the carcase, which is how producers are paid. In Scotland, beef and sheep carcase evaluation is based on the EUROP grid which assesses carcase conformation and fatness and determines the price per kilogramme paid to the producer.

The main value components of a carcase are the yield of saleable meat and the eating quality of the meat. The current EUROP carcase evaluation system does not permit consumer preferences to be reflected in the price, or consumer preference information to be transmitted along the meat value chain to processors and producers. Although correlated to saleable meat yield, the relationship between saleable meat yield and the EUROP conformation and fatness is inconsistent. Taking these two points together, there is currently no financial incentive to improve saleable meat yield or meat quality.

Bearing in mind that both meat producers and processors ultimately supply consumers, there is a need to consider meat quality. It is clear from previous research conducted by QMS that there is considerable variation in meat tenderness and overall liking and that consumers would pay less than half the price per kg for meat of inferior eating quality compared to the price they would pay for good every day eating quality. Conversely consumers are willing to pay extra for better than every day eating quality. A growing body of evidence from consumer research also shows that poor eating quality (of which poor tenderness is the key driver) is the main reason that consumers do not repeat their purchase of meat.

There is a clear need to re-define how carcases are evaluated for payment purposes so that producers and processors can match meat supply to consumer demand. Carcase evaluation needs to incorporate a direct assessment of saleable meat yield and meat quality information. When linked to a payment system, carcase evaluation based on this principle would create a price mechanism that would better connect the meat value chain. A payment system linking consumer attributes to carcase evaluation would allow producers and processors to work together to match supply with consumer demand.

Why is work needed?

Video image analysis (VIA) has been implemented for beef carcase evaluation for a number of years in the Republic of Ireland, but only gained approval for use in the UK in 2010. VIA mimics the carcase evaluation process by automatically assessing a side of each carcase according to the EUROP classification grid but VIA provides additional information on carcase composition. VIA can also predict saleable meat yield of the carcase and the weight/yield of various primal cuts, which vary widely in value. Although this cannot be done by a manual classifier, there are clear benefits for taking a yield-based approach to carcase evaluation because the actual meat value can be more accurately reflected in the carcase evaluation and the price paid to producers.

Figure 1: Images of a carcase from the VBS 2000 VIA system

Such a system works well for meat yield, but selecting for increased yield can have a detrimental effect on the meat quality, particularly by increasing toughness and reducing overall consistency (as was seen in pigs). Visible-near infrared (NIR) spectroscopy is a means of measuring some meat quality parameters based on a surface scan of a cut meat surface (e.g. on the rib surface after quartering) which can be undertaken in a fast, non-destructive manner. The accuracy with which NIR can predict meat quality parameters such as colour, tenderness and ultimate pH has mostly been determined on experimental data collected under carefully controlled conditions. Consequently, at the start of this project there was a need to test NIR under commercial operating conditions to determine if the technology could be a useful tool for meat processors for measuring meat quality. Such a tool would enable processors to monitor product consistency or to incorporate a quality-based parameter into carcase evaluation.

Importantly, there was also a need to understand some of the sources of variation in meat yield and eating quality resulting from production and processing effects. Such information is required so that the value-chain can begin to understand and optimise their processes to better meet consumer demands.

What has been achieved?

Progress has been made in several areas. VIA has received much criticism on account that fatness predictions are poorer than conformation predictions. A systematic review of the literature found that when considering the percentage of carcase fat (needed in order to determine the saleable meat yield), the fat prediction was as good if not better than the saleable meat yield prediction. This was consistent with findings of other researchers who had noted that the relationship between EUROP and saleable meat yield is inconsistent, which was also shown experimentally in the current project. From the literature it was noted that VIA is very good at predicting the saleable meat yield of the whole carcase with a relatively high accuracy (Table 1). When considering the distribution of meat throughout the carcase, it was concluded that VIA can predict the weight and yield of the high-value sirloin and fillet cuts, but that the primal predictions could be further refined to improve accuracy and utility.

Table 1: The percentage accuracy (0-100%) of VIA from published experiments

Component	All VIA studies
The percentage of saleable meat in a carcase	67%
The percentage of excess fat in the carcase	78%
The percentage of bone in a carcase	74%
EUROP Conformation (15 point scale)	88%
EUROP Fatness (15 point scale)	78%

Production and processing effects

The meat quality of beef and lamb was comprehensively assessed for genotype and sex effects to gauge the magnitude of these effects and to establish if they were likely to pose a problem to a meat quality orientated approach to carcase evaluation. Statistically significant effects were detected, but in most cases it was shown that they were unlikely to affect the eating quality in terms of consumer acceptability. One exception to this was the meat quality of bull beef, which tended to be at a greater risk of having a high ultimate pH which can lead to a reduced shelf life and increased toughness, although the propensity of bull beef to have a high ultimate pH actually had a masking effect on the shear force values (beef with very high ultimate pH tends to be more tender). An example of dark cutting beef loin is shown in Figure 2.

Figure 2: Dark cutting meat with a high ultimate pH (left) and normal pH meat (right).

The effects of the sex and the Texel muscling gene on lamb meat quality were also investigated. Statistically significant effects were detected for the sex (with meat from males being slightly tougher than females), but such a small difference was unlikely to affect the eating quality in terms of consumer acceptability. This work showed that farmers may not need to castrate male lambs to improve meat eating quality. There are clear benefits in terms of better animal welfare and reduced labour if castration can be avoided.

The effects of the Texel muscling gene on the meat quality of the loin and topside cuts were also ruled out (Figure 3), provided the meat was aged for at least seven days.
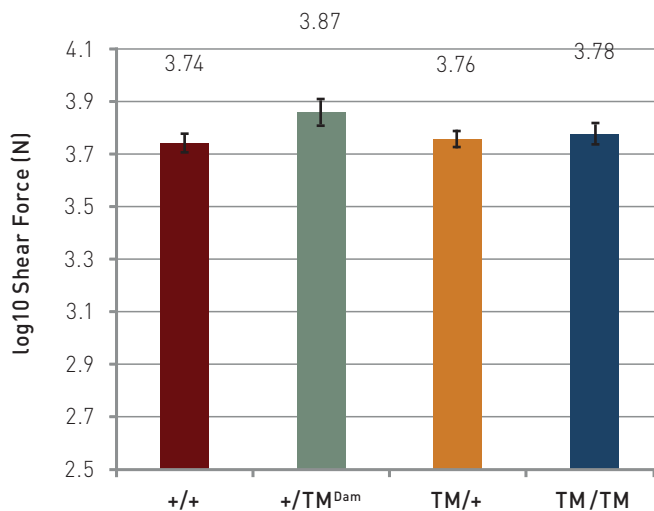
Figure 3: A graph showing that there were no statistically significant differences between TM QTL genotypes for the peak shear force of the topside muscle.

Prediction of meat quality

Visible-near infrared spectroscopy data recorded at the abattoir was tested to predict beef quality. Using one analysis method, good predictions of pH were obtained (Figure 4) suggesting that the technology may be used to identify beef with a high pH (Figure 2).
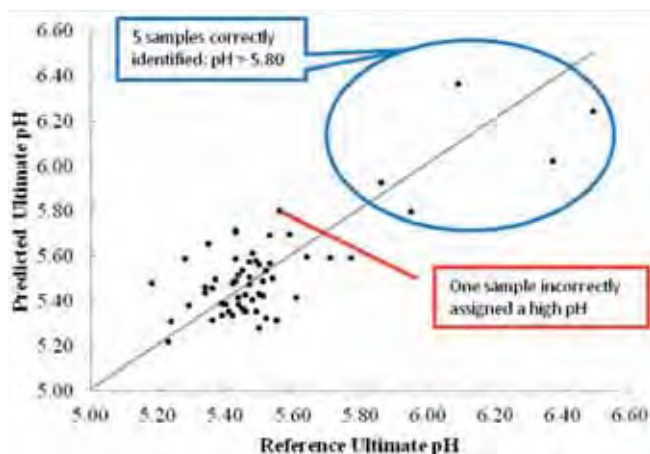

Figure 4: A plot illustrating the predictive ability of NIR for detecting beef with a high ultimate pH

Prediction of colour was also good, but shear force prediction was poor. Other analysis methods have since been deployed that have improved the prediction of shear force to a level useful for identifying very tough or very tender sirloin steaks. Further work is underway in other QMS projects to improve the prediction accuracy for shear force since it is indicative of tenderness. NIR was also tested on lamb meat and showed a good propensity to predict the level of intramuscular fat in the loin, but the highly consistent nature of lamb meat meant that constructing a prediction for tenderness and pH was difficult.

Figure 5: A close-up picture of the slice shear force test on beef loin. The force required to cut through the meat sample is an indicator of tenderness – the more force required, the tougher the meat.

Benefits to industry

This project has thoroughly investigated two of the possible technologies that may contribute to a carcase evaluation system based on saleable meat yield and meat eating quality. It was important to test the technologies using carcases and meat from cattle representative of the Scottish beef cattle population to determine the applicability of VIA and NIR under Scottish commercial operating conditions. The results have shown the VIA can effectively be used for EUROP and total carcase saleable meat yield predictions but that the prediction for individual primal yields should be calibrated to reflect primal definitions used in Scotland. NIR showed some promise for measuring the loin meat quality and may be used for identifying extremes, but further research is needed to establish how the technology works on other cuts and whether it is highly processor-specific.

This project also highlighted some prerequisites to a more consumer-focused carcase payment system. Some of these include:

- The definition of eating quality criteria and agreement on definition across industry.
- Establishing causative factors and liability for poor eating quality.
- Determining what can be done with meat of inferior quality (improve or remove).
- Decide how any added value from improved quality may be apportioned across the value chain.
- Determine how such a system may be funded and implemented.

This work has clearly shown that technology that is currently available can improve the carcase evaluation process. More work is underway to determine how image-based technologies (including NIR) perform for predicting tenderness and pH in a number of beef processing plants to establish the robustness of the technique.

Development of an iPhone app (SOCiT) for prediction of soil organic matter and carbon content in Scottish agricultural soils

Institute: The James Hutton Institute

Principal Investigator: Matt Aitkenhead

Status: Completed

The problem

Carbon stored in soils can provide multiple benefits, both to farmers and the wider society. In terms of soil health and fertility, carbon in the form of organic matter improves soil structure, supports nutrient provision to crops and increases soil water buffering capacity. Carbon storage in soils is also recognised as one of the best strategies for removing carbon dioxide from the atmosphere and mitigating against climate change.

For farmers to be able to manage their land in a way that increases soil carbon sequestration and long-term storage, they need to be able to monitor soil organic matter content rapidly and cost-effectively. Physical sampling and chemical analysis provides highly accurate measures, but also takes time and costs money. This cost increases rapidly when multiple samples are to be analysed.

Scientific understanding of the effects of topography, climate, vegetation and other factors on the organic matter content of soil has improved in recent years, allowing the development of models that can make effective predictions of organic matter content. The fusion of modelling approaches with modern mobile phone technology could provide a solution to the problem of measuring soil organic matter content, by providing mobile phone applications that can be used in the field, without the need for soil science expertise or training.

What has been achieved so far?

A neural-network based model for predicting topsoil organic matter content has been developed which gives predictions of organic matter (OM) content for mineral soils (OM range 0-20%), with an error range of 1% of OM content. The model is applicable for all agricultural mineral soils in Scotland that lie below 300m in elevation.

The model implementation by itself is a useful tool, but not one that can be readily used by stakeholders. In order to improve usability and increase access to the model, an iPhone app has been developed. This app enables the user to use images of soil profiles, coupled with geographical location (this information is automatically stored within the photograph as it is taken) to get a prediction of the topsoil organic matter content of the soil. The app is easy to use, contains instructions and automates many of the tasks required.
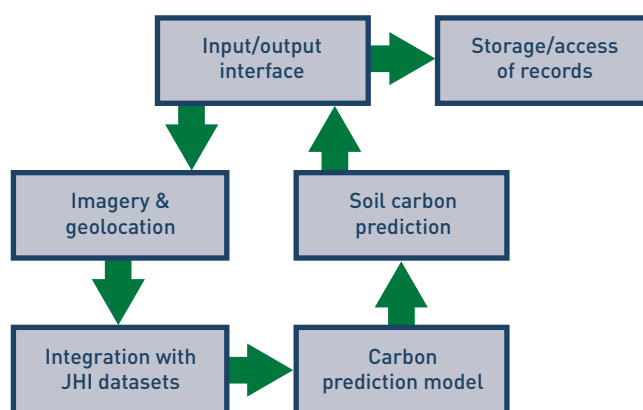
The structure of the model behind the app.

Fusion of the soil organic matter model with the "front end" app has been achieved by developing a dedicated server-based framework for acquiring information about the environmental characteristics of a site being investigated. The geographical location from which the photo was taken is used to interrogate a number of spatial datasets, producing information about topography, climate and vegetation associated with that location. This information is fed into the model and a prediction of both topsoil organic matter and carbon content produced. The results are returned to the user's iPhone, usually within 30 seconds of the initial request being made.

Instructions for use of the app have been produced, and incorporated into the app. The instructions are easy to follow and enable users equipped with an iPhone, a colour correction card and a spade to obtain an estimate of topsoil organic matter content within approximately five minutes.

Results

Successful operation of the app requires that the user takes a photograph with their iPhone of a shallow soil pit. Detailed user instructions for how to do this are provided. The user must take the image including in the shot a colour correction card that is provided for free to farmers. The app has been tested in the field against soils for which topsoil organic matter content is known, and has been shown to be accurate to within 1% of organic matter content 90% of the time (i.e. for a predicted topsoil value of 5.4%, the user can be confident that the actual value lies between 4.4 and 6.4%). This comparison has been made against results obtained with conventional lab testing, which is more accurate but which takes significant time to get results and costs money. The app can provide good predictive ability for free, and can be used as often as the user wants.

Digging the test hole.

Scan here to download the app:

The colour card can be obtained either from Matt Aitkenhead at the James Hutton Institute or from QMS via **info@qmsscotland.co.uk**

Benefits to farmers

An accurate model for prediction of soil organic matter has been implemented within an iPhone app that can be used rapidly and easily, with no training required. Farmers in Scotland will therefore be able to get useful information about the organic matter status of their soils. This will enable them to make more informed decisions about the management of their land, and will allow them to understand better the condition of their soil.

The test hole with colour card in place.

The app in the store.

Optimising the UK sheep industry by the inclusion of Genotype x Environment (GxE) interactions

Institute: Scotland's Rural College (SRUC)

Principal Investigator: Ann McLaren

Status: Ongoing

The problem

The UK sheep industry has a diverse range of farming systems which operate in an equally diverse range of environments. Associated with this is a considerable variation in animal performance which may arise from an interaction between the animal genotype and the environment (GxE) in which it is farmed.

Why is work needed?

Figure 1 demonstrates the offspring performance of two rams across three different farms. The presence of GxE interactions can lead to a scaling effect, shown between Farm B and Farm C, where although there are performance differences, Sire B is still better than Sire A. However, such interactions can also lead to re-ranking, shown between Farm A and Farm B. In terms of sire-reference schemes, or other such breeding programmes, re-ranking can be extremely detrimental and lead to the selection of inappropriate breeding stock. It also has implications for commercial producers buying recorded sires for specific traits, as these sires may perform unexpectedly when used on their farm. Overall, the presence of GxE interactions can have a negative impact on the economic and genetic performance.

Figure 1. Offspring performance of two rams across three farms.
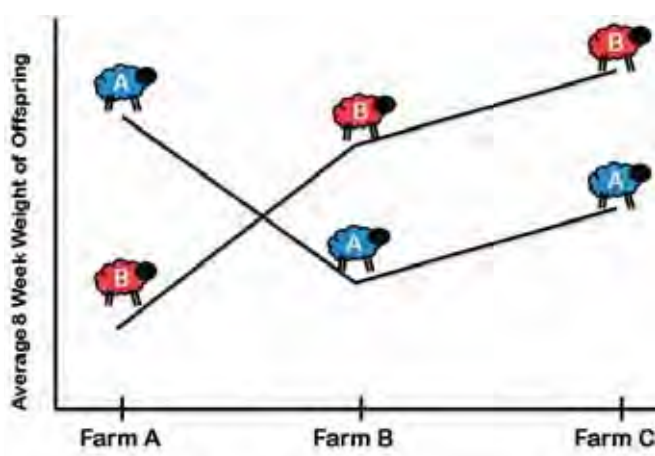
What has been done so far?

Are GxE interactions present in any of the lamb or ewe traits recorded in hill breeds?

The presence of GxE interactions between two Scottish hill farms, with markedly different environments, was investigated. Both lamb and ewe traits were studied (Table 1). Overall the analysis identified significant GxE interactions for lamb birth weight and ewe pre-mating live weight. The GxE interactions found for lamb birth weight may have implications for lambing-associated problems, or lamb survival, if sires produce lambs with unexpectedly high or low birth weights. The presence of GxE associated with the pre-mating weight could have implications for ewe maintenance, with unexpectedly big ewes requiring more inputs such as feeding to maintain performance.

Table 1. Traits assessed in Scottish Blackface ewes and lambs

Lambs Traits	Ewe Traits
Birth Weight	Pre-Mating Weight
8-Week Weight	Litter Weight Weaned
Weaning Weight	No. of Lambs Reared to Weaning
Ultrasound Fat Depth	No. of Lambs Lost to Weaning
Ultrasound Muscle Depth	Age at Culling/Death (years)
Carcase Weight	Ewe Efficiency (Litter Weight Weaned/Pre-Mating Weight)
Carcase Fat-Class	
Carcase Conformation	

## Can commercial farms be classified into different environment types?

Data gathered from a questionnaire covering: land type; sheep numbers and breed; management of the flock throughout the year; and health treatments and labour, was combined with farm location details, lambing dates and regional weather data. The information collected from terminal sire breeders (Texel, Suffolk and Charollais), who record with SIGNET, was used to classify the sample flocks into different farm environments/management systems. The data available for 79 different flocks allowed three different cluster groups to be identified. The main factors distinguishing between them were the type of grazing available to the flock, throughout the year, as well as climatic conditions and the use of mineral and vitamin supplements (Figure 2).

Although only a small "snap-shot" of the overall UK terminal sire flock, the cluster groups identified demonstrate how a number of very different farming systems can be brought together to form similar environment/management groups. Following on from this, by using pedigree and performance data available, for flocks involved in the classification analysis, the presence of GxE interactions can be investigated between the different environment/management systems for traits such as lamb weaning weight and ultrasound back-fat and muscle scans. Early results from the genetic analysis of the Charollais flocks included in the cluster analysis has identified sires which have performed consistently across the cluster groups, as well as some which have re-ranked across cluster groups, suggesting GxE is present.

Benefit to farmers

There are three approaches available to breeders in terms of how they deal with GxE. The first option is to ignore it, risking poor and somewhat unpredictable performance flocks. Secondly, avoid GxE by selecting lines with wide adaptability across different environments or finally, exploit GxE by developing lines suited to the environments in which they are to be used. As a result, the current project aims to identify traits, and environments/systems, that are subject to GxE, enabling farmers to select "robust" animals, that have little variation in their performance across different environments, as well as those suited to specific systems. By reducing the negative effects of GxE, or by using their effects to their advantage, there is an opportunity for farmers to improve the level of genetic gain and the economic performance of their flocks.

Figure 2. Positioning of farms in the different cluster group identified.
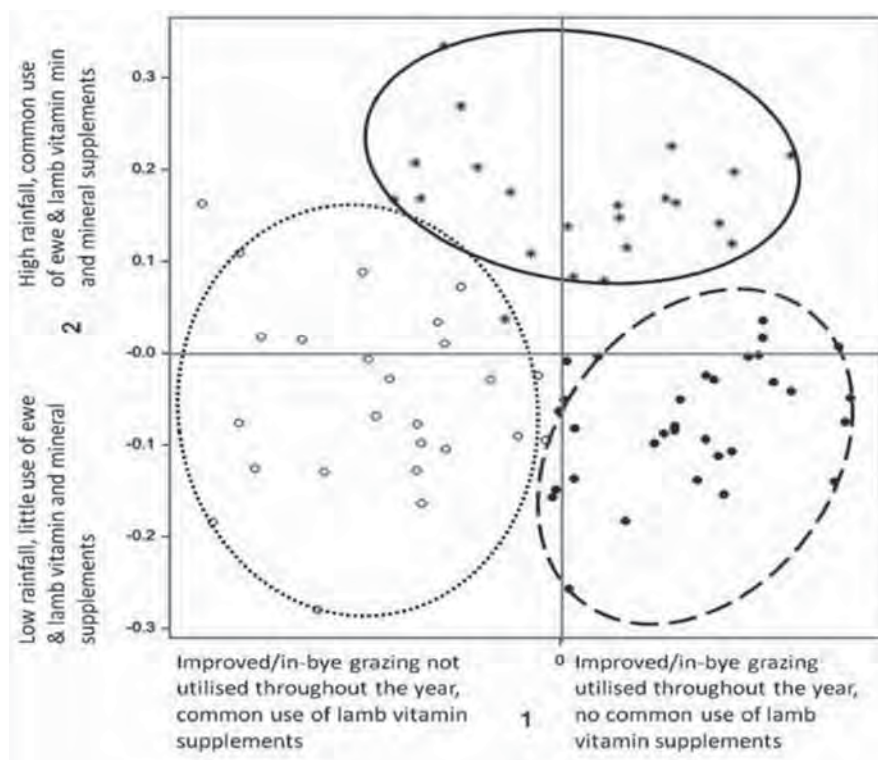
Sub acute ruminal acidosis – SARA

Institute: Consortium led by University of Aberdeen

Principal Investigator: John Wallace

Status: Ongoing

The problem

Sub-acute ruminal acidosis (SARA) is a disorder that can afflict all ruminant species, but one that is particularly prevalent in intensively managed dairy and beef cattle. It results from disturbance of ruminal microbial ecology and leads to damage and dysfunction of the ruminal wall tissue which is only seen post mortem (Figure 1).

SARA might be regarded as mainly an unseen, and most certainly under-researched, disorder because its symptoms are those of poor performance rather than obvious illness. However, next to the ill-thrift, SARA can be associated with laminitis and diarrhoea and thereby also increased involuntary culling. Its economic impact is therefore hard to determine exactly, but it is estimated that the UK beef industry may be losing more than £100m per annum to SARA.

Figure 1. Healthy rumen wall tissues (left) and necrotic rumen wall tissue from an animal with subacute ruminal acidosis (right). These changes are often not evident until after heat treatment of the rumen, as in this picture.

Why is work needed?

There is a lack of information on the causes of SARA: what the key risk factors are; why some animals are more susceptible to the condition; and how it can be treated and addressed through management practices. These knowledge gaps need to be filled so that the costs to the industry from SARA can be reduced or even removed.

What has been achieved so far?

The project has two main objectives:

1. *To explain the underlying causes and mechanisms of the development of SARA in beef and dairy cattle*

2. *To devise means – nutritional, management, feed additives – by which SARA can be treated and/or prevented in susceptible animals.*

So far, diets and farm management practices have been compared across 12 farms in Aberdeenshire, in an attempt to identify those farms at most risk.

Although the diets contain similar constituents, different mixing and processing results in very different physical forms; some feeds are characterised by mainly large particles, others are quite dusty.

Figure 2. A comparison of diets created from similar components but with different physical forms; large particles (left) or small particles and dusty (right)

The latter is assumed to be a diet that makes animals more susceptible to SARA. Sixty cattle from these farms have now been sampled at slaughter.

Some rumen walls have been found to be very badly damaged. The entire dataset is still being established to try to figure out – why?

Benefits to farmers

Being able to understand the risk factors, achieve optimal management practice to reduce the incidence or prevent SARA and possibly develop dietary supplements that might reduce the risk of SARA would benefit farmers through improved livestock performance. Benefits will also be seen through a reduction in losses in the fifth quarter for processors.

New Data Analysis Techniques for Prediction of Eating Quality in Beef and Lamb

Institute: University of Strathclyde

Principal Investigators: Tong Qiao and Jinchang Ren

Status: Ongoing

The problem

Consumers can only assess meat visually but this does not give them any information as to the eating quality of the product. Eating quality can be assessed in the laboratory or by using taste panels, but these types of test are expensive, destructive and time consuming (see Figure 1).

Figure 1. Traditional methods for measuring meat quality using a pH meter for pH (top) and a portable colorimeter for colour (bottom).

Why is work needed?

Hyperspectral imaging (HSI) uses an image based approach to offer a rapid non-destructive means of assessing the eating quality of meat. To explore this approach for beef and lamb, new data analysis techniques are required to map the spectral data to a series of quality-related metrics, using computer based machine learning approaches.

What has been achieved so far?

The project aims to apply novel 'machine learning' analytical approaches to meat quality assessment by HSI to refine the prediction of meat quality parameters such as tenderness, cooking loss, pH and colour in beef and lamb. Three main techniques to be used include:

- principal component analysis (PCA),
- support vector machine (SVM),
- sparse representation.

Large numbers of hyperspectral images of beef samples are being acquired from Scottish abattoirs. The beef hyperspectral image is illustrated in Figure 2, where three bands with wavelength of 435.5 nm, 546.1 nm and 700 nm were used to form a pseudo colour image for better visual effects. The spectral profiles of the fat and lean in the piece of beef are also plotted in Figure 2. Usually the spectral profiles are used as features. However some spectral bands are more distinguishable than others. Therefore, feature selection is desirable.

So far the project is focusing on feature selection and data reduction, where PCA is employed as it is one of the best methods to represent band information in HSI. In PCA, the spectral data are transformed to a new domain where differentiability is higher in a subset of the transformed features than in any subset of the original data. After PCA, the first three principal components (PCs) were found to have preserved about 98.57% energy of the whole dataset. Thus, the dimensionality of the dataset has been reduced from 250 to three.

In Figure 3, the first three PCs in the selected beef dataset are plotted, where the fat and lean can be separated by a plane in the new PCA domain.

Figure 2. A psuedo colour hyperspectral image of a beef sample (left) and the associated spectral profiles of the fat and lean in the beef (right).
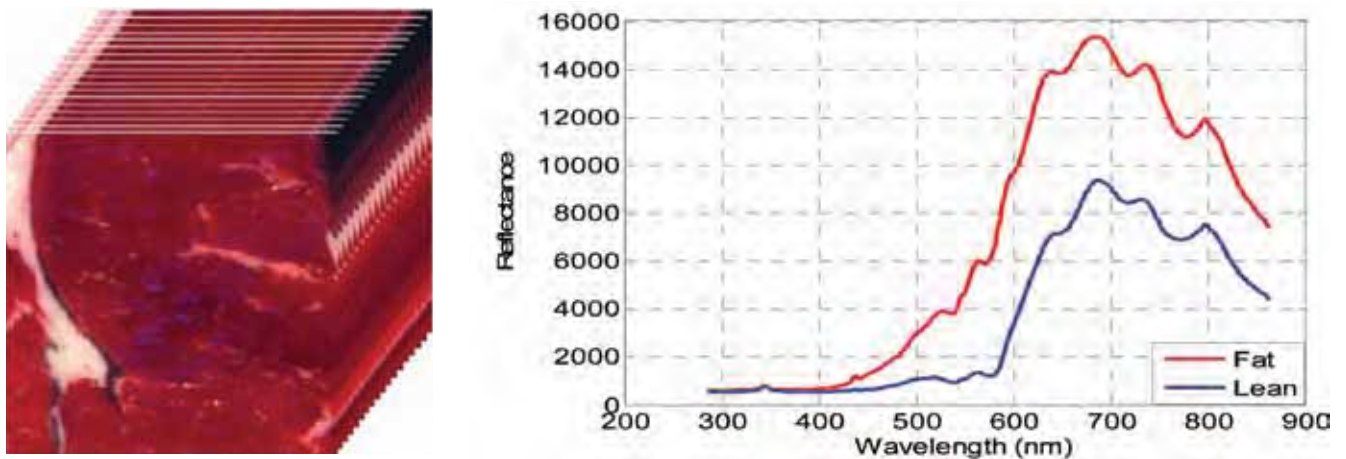
Figure 3. The first three principal components of the fat and lean in the beef sample.
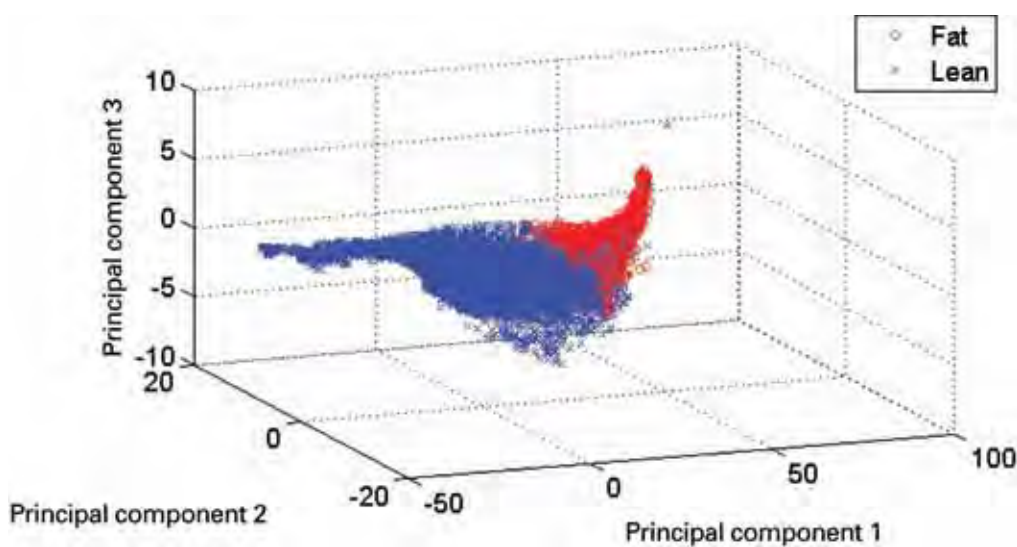
Benefits to farmers

Hyperspectral image based analysis has already been adopted in other industries for the assessment of quality. The technology has the potential to provide accurate, rapid, non-destructive analysis of foodstuffs such as meat. By developing, calibrating, testing, and validating the hyperspectral imaging system, the project aims to develop further the approach for meat so that a multispectral imaging system employing only a few effective wavebands can be evolved. This would provide an attractive solution for the analysis of beef and lamb eating quality in a commercial setting to deliver information for farmers and processors.

Effect of the Texel muscling QTL (TM-QTL) on spine characteristics in purebred Texel lambs

Institutes: University of Edinburgh and Scotland's Rural College (SRUC)

Principal Investigator: Claire Donaldson

Status: Ongoing

The problem

Previous work on the Texel muscling quantitative trait locus (TM-QTL) has found that the effect of its inheritance can result in a pronounced increase in loin muscling. Interestingly, this effect is largest in progeny that inherit only a paternal copy of the TM-QTL (Table 1).

Using cross-sectional computed tomography (CT) scans taken at the 5th lumbar vertebrae, two-dimensional measurements were taken to describe loin dimensions. The loins of TMSire/+Dam genotype lambs were reported to be ~3 – 11% greater in depth, width, and area compared to the other three genotype groups. Yet, it is unknown how (or if) a change in loin muscle size (due to the TM-QTL effect) may also be associated with any change in the characteristics of the spine section on which it lies.

Table 1. Example of possible TM-QTL genotypes of progeny from a particular cross. Diagram highlights the genotype group where the largest loin muscling was observed.

	TMSire	+Sire
TMDam	TMSire/TMDam	+Sire/TMDam
+Dam	TMSire/+Dam	+Sire/+Dam

Why is work needed?

Recently, with the use of computed tomography (CT), spine characteristics (e.g. vertebrae number, vertebrae length) of the thoracolumbar (thoracic plus lumbar, see Figure 1) region in Texel sheep have been identified to exhibit significant variation. So far vertebrae number has been reported to range from 17 to 21 among individuals. This vertebral variation is one factor which contributes to the different body (and carcase) lengths observed from individual to individual. In fact, it is along this thoracolumbar spine section which the loin runs parallel, and its length is therefore directly linked to an animal's body length.

The TM-QTL inheritance and vertebral variation have each been demonstrated to influence the structure of the loin and each may have the potential to be used to increase loin production. However, it is important to investigate if there is a change in spine characteristics related to an increased muscling of the loin i.e. is there an association between spine characteristics and the TM-QTL? This is particularly relevant to assess in terms of a possible 'trade-off' between loin muscle size and spine length i.e. is selection for increased loin depth at the expense of spine length (vertebrae number and/or length)?

Figure 1. Diagram showing the five different regions of the spine.
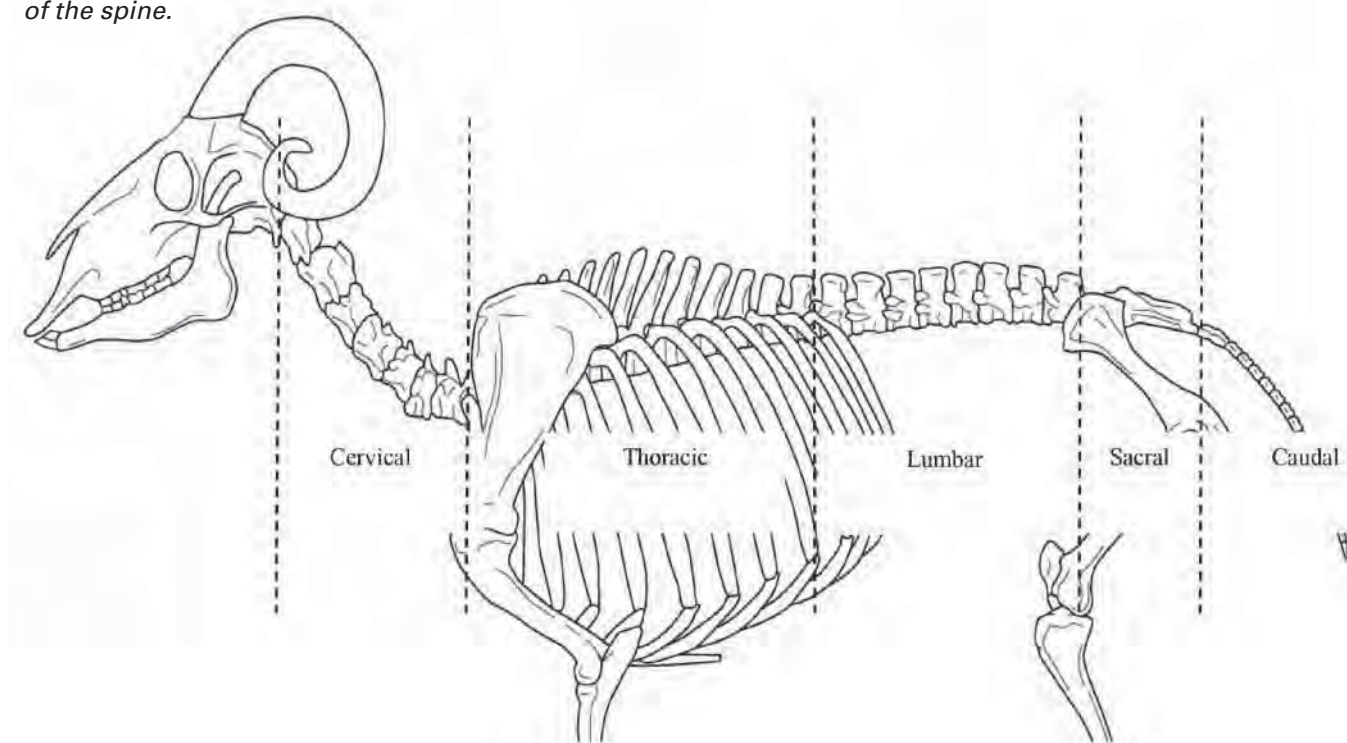
What has been achieved so far?

Records for a total of 142 purebred Texel lambs kept across two sites, one in Scotland and one in Wales, were used in the analysis. These lambs had been previously genotyped (Table 2) and scanned using CT. Images produced from the CT process allow the thoracic, lumbar, and thoracolumbar spine regions to be distinguished, and certain characteristics to be measured, these included: number of vertebrae, length of vertebrae and length of spine region.

Table 2. Description of the number (n) of animals in each genotype group.

	TM-QTL Genotype			
	$+^{Sire}/+^{Dam}$	$TM^{Sire}/+^{Dam}$	$+^{Sire}/TM^{Dam}$	TM^{Sire}/TM^{Dam}
n	39	52	17	34

Figure 2. Graphical presentation of the average length (mm) of the thoracolumbar spine region across the four TM-QTL genotype groups.
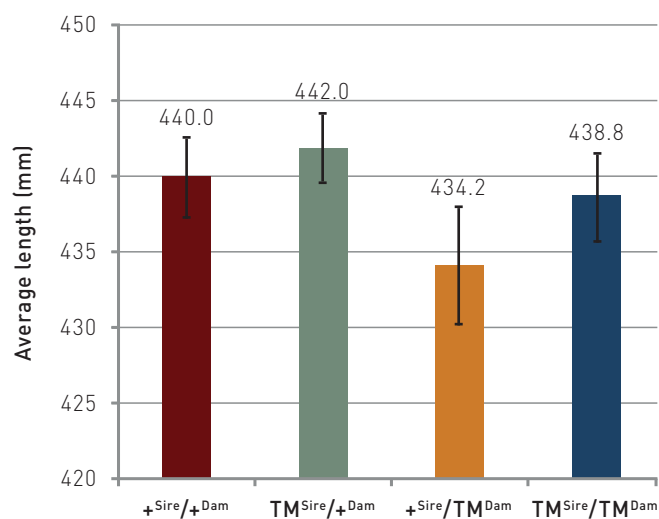
Although the data set is small, it is sufficient in size where results would still be expected to reveal any major advantageous or disadvantageous associations between TM-QTL and spine characteristics (Figure 2).

Benefits to farmers

There do not appear to be any negative effects on spine length in animals which have a loin muscle that is larger in depth, width and area measures.

Plochteach in sheep – a review of the literature

Institute: Scotland's Rural College (SRUC)

Principal Investigator: Meg Pollock

Status: Complete

In North West Europe, including Norway, the Faroe Islands and the British Isles, a disease in sheep that graze extensive upland pasture is known by a series of local names; Plochteach (Highland Scotland); Yellowses; Head-greet; Saut (Northern England); Alveld (which literally means 'Elf-fire' in Norwegian). All are presumed to be the same disease or disease complex.

In Scotland, a particular form, yellowses, 'head-greet' or Plochteach (pronounced "ploch-tea") is highly prevalent in the west and north west Highlands where it is reputed to affect as many as 10% of lambs born. Animals suffering from Plochteach become dull, cease eating (possibly due to a swollen, painful mouth) and seek shade. The fleece 'breaks' along the backbone and skin damage to the back of the animal becomes evident and facial lesions, especially to the ears, make tagging virtually impossible. The disease typically affects lambs, with adult sheep rarely showing symptoms. Mortality, often unseen on open hills, is considered to be high and surveys and anecdotes have highlighted the disease as a major impact on losses after the peri-natal period with loss of production evident in very poor quality lambs that do survive. White sheep are reported to be more prone to the disease than black sheep and it appears that genetics may be important with certain breeds appearing to be more resistant than others. It has also been suggested that selective breeding for traits associated with increased production may also have had an impact.

Plochteach is known to have first been reported in the Veterinary Statistics for Norway in 1891 and the first study of the disease was carried out in 1908. Bog Asphodel (Narthecium ossifragum) has been associated with the disease since 1916 but whether this is the causative agent or whether it is one of several possible triggers including other plants, micro-organisms, fungi, parasites, toxins etc is still a matter of debate .

Surprisingly, little is known about the time-course of the disease in practice on Scottish hills and there is no systematic data available on the incidence of the disease in the UK.

Figure 1. Lambs with milder symptoms of Plochteach, one with damage and part loss of ears (top) and another with hair loss along the back (bottom).

There are currently no specific treatments for animals suffering from Plochteach. Treatment of affected animals is mainly targeted on limiting pain and suffering and reducing further damage. The recommendations involve removing animals from sunlight if at all possible and placing them in darkened areas for around a week, with plenty of water.

It has been suggested that the administration of corticosteroids in early stages may also help. If found early and treated to reduce further damage the chance of recovery is good. However, in severe cases animals may die from shock and/or from untreated secondary infection. Although any recovery will depend on the severity of the case, mild cases may show recovery within a few days while more severe cases can take weeks.

Land management approaches to control livestock access to plants such as Bog Asphodel thought to be involved in the development of the condition are very challenging. The use of draining, tree planting to create shaded areas, application of lime and phosphorous to increase grass growth and competition, have all been tried elsewhere with varying success. These approaches however are difficult to apply in extensive grazings which may be protected by a range of regulations which would mean that specific permission would need to be sought.

Plochtech is clearly a highly complex disease, and many of the areas where knowledge is lacking are exacerbated by the remote nature of the hill farming environment in which the disease is prevalent. There is clearly an urgent need for a better understanding of the cause of this disease. To devise optimum management strategies to avoid the disease risk if possible, and to develop practical therapeutic approaches for the treatment of affected animals. In the longer term, the identification of genetic differences in disease susceptibility, and early diagnostics could make an impact to reduce the incidence of the disease in Scottish hill flocks.

Control of cattle parasites sustainably

Institute: Consortium of Industry Bodies

Principal QMS Contact: Charlotte Maltin

Status: Ongoing

The problem

Evidence suggests that cattle parasites are becoming more prevalent, and for some there are issues of increasing drug resistance. Parasites impact on a livestock producer's ability to achieve best performance from the livestock; feed conversion efficiency, growth rates and fertility can all suffer. There is a need for clear information to be available throughout the industry as to the best means to control parasites sustainably.

What is COWS?

COWS is a group of industry bodies which have come together to develop and implement actions to support the industry in controlling cattle parasites in a sustainable manner. In particular the group will focus on providing a supply of high quality accessible information for industry.

What has been achieved so far?

The consortium has regular meetings and is working on producing updated advice for the industry and for vets and advisors.

In addition, COWS held a Fluke Summit workshop to identify the gaps in scientific and practical knowledge about the control of fluke – liver fluke and rumen fluke in particular and to identify means to address these gaps. Industry representatives, scientists, vets and farmers all met together in Liverpool and identified key areas where knowledge was needed.

Three general areas were identified:

1. Diagnostics for liver fluke and rumen fluke

2. Therapeutics and drug resistance

3. Control – vaccination, breed resistance, management of pasture and of stock, disease forecasting

Within these areas, specific areas that needed more research were identified. The group is planning to work with the scientists to find ways to fill these knowledge gaps.

Benefits to farmers

Farmers will benefit from the work of the COWS group through the supply of high quality information to assist them in controlling cattle parasites in a sustainable manner.

COST action FA1102: FAIM (Farm animal imaging)

Institute: Scotland's Rural College (SRUC)

Principal Investigators: EU wide consortium led by Lutz Bünger

Status: Ongoing

What is COST?

COST is a flexible, fast and efficient intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of nationally-funded research on a European level with a very specific mission and goal. It allows the bringing together of good scientists and representatives of the industry under light strategic guidance. COST is based on networks, called COST Actions, centred around research projects in fields that are of interest to at least five COST countries. Thereby COST contributes to reducing the fragmentation in European research investments and opening the European Research Area to cooperation worldwide. COST acts as a precursor of advanced multidisciplinary research, and it plays a very important role in building a European Research Area. It anticipates and complements the activities of the EU Framework Programmes, and builds "bridges" towards the scientific communities of emerging countries. It also increases the mobility of researchers across Europe and fosters the establishment of scientific excellence in nine key domains. The COST Action FAIM is in the Food and Agriculture domain (http://www.cost.eu/about_cost)

Who is in the COST Action?

This unique COST Action (FAIM) brings together ~120 to 200 experts from so far 20 (25) EU countries (and beyond). The number of participants is steadily growing. (http://www.cost.eu/domains_actions/fa/Actions/FA1102). FAIM started in late 2011 and will be "on the road" until 2015. The figure below shows the management structure.
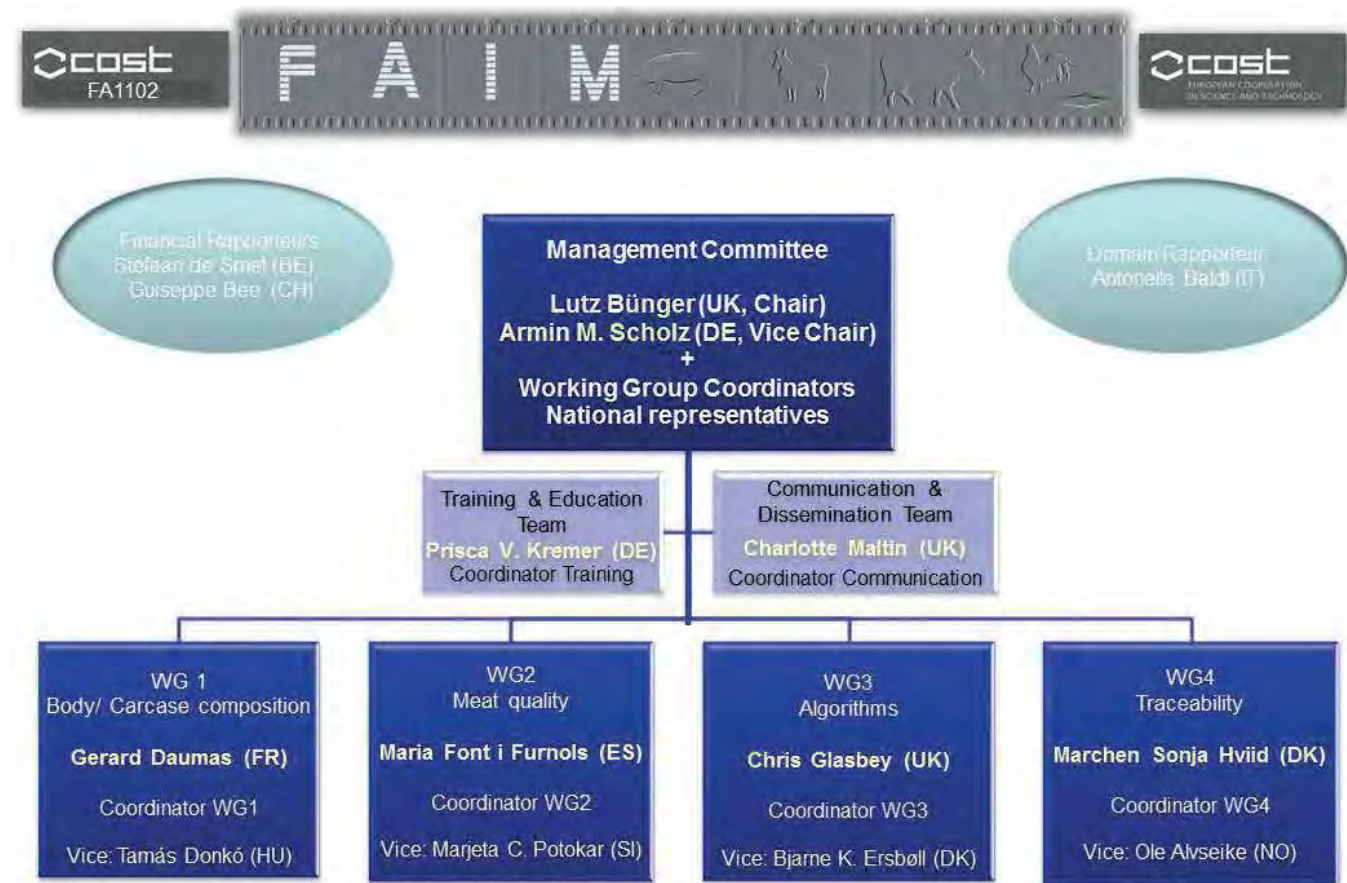
What is the COST action FAIM about?

The title says it all, (almost!).

Optimising and standardising non-destructive imaging and spectroscopic methods to improve the determination of body composition and meat quality in farm animals (FAIM).

FAIM aims to optimise non-destructive in vivo (iv) and post mortem (pm) imaging and spectroscopic methods for the measurement of body composition and meat quality (MQ) in major farm animal species and to devise standardised principles of carcase classification and grading (CCG) across countries. These actions are necessary for the development of value-based payment and marketing systems (VBMS) and to meet the urgent need for market orientated breeding programmes. FAIM encompasses collaboration of hardware and software manufacturers with livestock and imaging academic experts to develop required products for implementing the scientific work. FAIM will coordinate and strengthen EU scientific and technical research through improved cooperation and interactions. This will be essential for achieving the required advances in CCG systems to measure carcase yield and MQ, to meet the industry need for VBMS, and to improve production efficiency throughout the meat supply chain (MSC). FAIM will also support EU legislation on individual animal identification through showing the additional benefits of feeding back abattoir data on individual animals for optimising management, breeding and providing phenotypic information which will facilitate future implementation of genome wide selection.

The Objectives:

- *to review and develop robust references from imaging technologies for measuring body and carcase composition*
- *to review and develop harmonised procedures for in vivo, post-mortem and on-line imaging methods of predicting compositional traits*
- *to review and develop harmonised procedures for in vivo, post-mortem and on-line imaging and spectroscopic methods of predicting meat quality in livestock*
- *if full automation cannot be achieved, a lesser option is provided by semiautomatic methods, where results are obtained through human computer interaction*
- *to review and harmonise methods and equipment for individual animal traceability to optimise management, breeding and permit the future use of genomics.*

The means:

Annual Conferences (AC): first and latest (FAIM I) was in Dublin hosted by Teagasc Food Research Centre, Ashtown, Dublin, 24th – 26th September 2012. The second AC (FAIM II) will be in Kaposvár/Hungary (Kaposvár University; 29 & 30 October 2013).

Workgroup meetings: mainly in connection with the AC but there is more: e.g. WG1 met in Jan. 2013 in Lyngby. Use of phantoms in computed tomography, e.g. WG 1 and WG2 will meet during the EAAP 2013 (26-30 Aug.) and FAIM will organise one session: Carcase and meat quality: from measurement to payment. e.g. WG3 will meet on "Farm Animal and Food Quality Imaging" in Espoo, Finland as satellite to Scandinavian Conference on Image Analysis (SCIA'13): 17/6/2013 and all WGs will meet at FAIM II in October.

Training schools: we had 2 TS in 2012: (1) on image analysis in Lyngby, Denmark May 2012, (2) on Farm Animal Imaging & Carcase/Meat Quality in Oberschleissheim and Kulmbach Germany, October 2012.

Participants in the FAIM training school in Lyngby, Denmark, May 2012

STSMs (in full: Short term scientific missions): We had 6 STSMs in 2012 and we have the capacity to support more. Please come forward and ask!!

Where to find information about FAIM:

The Action website: http://www.cost-faim.eu

FAIM website at main COST site: http://www.cost.eu/domains_actions/fa/Actions/FA1102

Domain website: http://www.cost.eu/domains_actions/fa

We have quite a few passengers on the FAIM bus; we want also more drivers!

Would you like to participate? Email me! Lutz.Bunger@sruc.ac.uk

Improving the control of liver fluke infection in cattle in the UK

Institutes: Consortium – University of Liverpool, Moredun Research Institute, Centre for Ecology and Hydrology and Scotland's Rural College (SRUC)

Principal Investigator: Diana Williams

Status: Ongoing

The problem

Fasciola hepatica, the liver fluke, is a common and ubiquitous parasite affecting the health and welfare of cattle worldwide. Fluke infection costs the UK agriculture industry somewhere in the region of £300 million per year due to production losses with liver condemnations alone costing £3.2 million in 2010. Evidence from various sources suggests that the prevalence of infection has increased considerably in recent years for a variety of reasons – changing climate, changing farming practices and increased animal movements.

Why is work needed?

There are growing concerns about drug resistance and withdrawal of drugs used to treat milking cattle and we know that a fluke modulates its host's immune system and affects diagnosis and susceptibility to other pathogens including bovine tuberculosis. The farming industry is in urgent need of improved means to control the disease reducing reliance on drugs.

What has been achieved so far?

The project has just been awarded funding.

The work is divided into five interlinked work packages:

- WP1: Development and validation of herd level diagnostic tests, to identify farms with fluke infection and to discriminate between liver fluke and rumen fluke infection.

- WP2: Field level classification of snail habitats and identification of factors that influence contacts between cows, snails and the parasite.

- WP3: Identification of on-farm risk factors for liver fluke infection in cattle enterprises and development of statistical and mathematical models to predict the likely benefits of implementing changes to farm practice on fluke prevalence.

- WP4: An economic analysis to define costs of fluke infection at herd and national level.

- WP5: Evaluation of on-farm intervention programme on reducing prevalence of fluke infection on cattle farms.

To ensure the outputs of the research are fed back to the industry the final component of the project is an implementation and impact programme in collaboration with the levy boards.

Benefits to farmers

The aim is to improve control of liver fluke infection in cattle by developing new management tools which will reduce the reliance on drugs. If successful the project will provide benefits in terms of better control and lower drug costs.

Epidemiology of cryptosporidiosis in farm livestock

Institute: Moredun Research Institute

Principal Investigator: Sarah Thomson

Status: Ongoing

The problem

Cryptosporidiosis is a parasitic disease which infects animals and humans. It is caused by a tiny single celled organism called Cryptosporidium which is invisible to the naked eye. The parasite is transmitted orally, through the consumption of the oocyst (egg) stage of the parasite which is shed in the faeces of infected animals. Once inside the animal the parasite attaches to the gut wall and causes damage to the intestine resulting in disease. Figure 1 shows a high magnification of the oocysts attached to the gut wall. During clinical infection one animal may shed up to 1×10^{10} oocysts and research at Moredun has shown that the minimum infective dose is as low as 1-10 oocysts. Therefore one infected animal can produce enough parasites to infect 1000 million other animals which is a phenomenal amplification rate.

Cryptosporidiosis is of great importance to the UK livestock industry as infected animals may suffer from diarrhoea, loss of appetite and dehydration; in severe cases infection may cause death. Those most at risk are young neonatal livestock around 2-10 days old. Veterinary surveillance reports show that in the past five years cryptosporidiosis has increased as a diagnosed cause of enteritis in calves and in 2011 Cryptosporidial infection was responsible for 35% of enteritis in calves less than one month old in Scotland. The CRYPTOBEEF project (QMS R&D 2010/11) reported increased severity of Cryptosporidiosis from farms in two areas of North East Scotland, where some of the farms reported losses of up to 30% of calves.

Figure 1. Cryptosporidium oocysts attached to the gut wall

Why is work needed?

At present, control strategies for Cryptosporidium are limited. There is no vaccine to prevent cryptosporidiosis and treatment options rely largely on rehydration therapy. The oocysts are highly resistant to common disinfectants and can survive and remain infective for long periods of time in the environment. This combined with the low minimum infectious dose makes Cryptosporidium a real challenge to control on the farm.

Very little is known about the species and strains of Cryptosporidium found in Scotland and even less is known about the pathogenicity of the different strains. Although it is currently not known whether some strains of Cryptosporidium are more likely to cause disease in cattle than others, it is known that there is variation in the pathogenicity of different strains in human infection.

What has been achieved so far?

Cryptosporidium species and genotypes found in calves

Initial testing of samples collected from young calves, for the presence of Cryptosporidium DNA showed that all calves were positive for Cryptosporidium in the first six weeks with peak shedding of oocysts occurring in week three. Interestingly, over half the samples from calves were found to be positive for Cryptosporidium at six months of age.

Speciation of positive samples showed that most animals in the first six weeks were shedding Cryptosporidium parvum with mixed infections and other species making an appearance from week three. Positive samples at three months were identified as Cryptosporidium bovis and Cryptosporidium ryanae which are the species most usually expected with this age group. These species have not been associated with any clinical signs at present.

What is more unusual is that the majority (70%) of positive samples at six months were identified as C. parvum. This is unusual because most literature suggests that after six weeks animals will no longer shed or be infected with C. parvum. Of the positive samples from the calves at nine months, three were identified as C. bovis, one as C. ryanae and two mixed infections of C. bovis + C. ryanae.

Genotyping of these samples is underway to identify different subtype (strains) of C. parvum which might be affecting these animals. It is generally thought that

farms have one dominant subtype which remains stable. It will be interesting to see if the same subtype is present in the calves at six weeks and six months or if another subtype is present.

From the results so far it is clear that Cryptosporidium is an important parasite which appears to be present on many farms and affects a lot of calves, even those that appear otherwise healthy. The main points to be taken from the work so far are:

- *Cryptosporidium is prevalent in calves up to at least six weeks with the most predominant species being C. parvum*

- *Contrary to current scientific belief based on previous findings, C. parvum was also the most prevalent species detected in calves at six months on one farm*

- *The same species and genotypes of Cryptosporidium are generally present on farms year after year*

- *Calves may be shedding Cryptosporidium even if they do not show clinical signs*
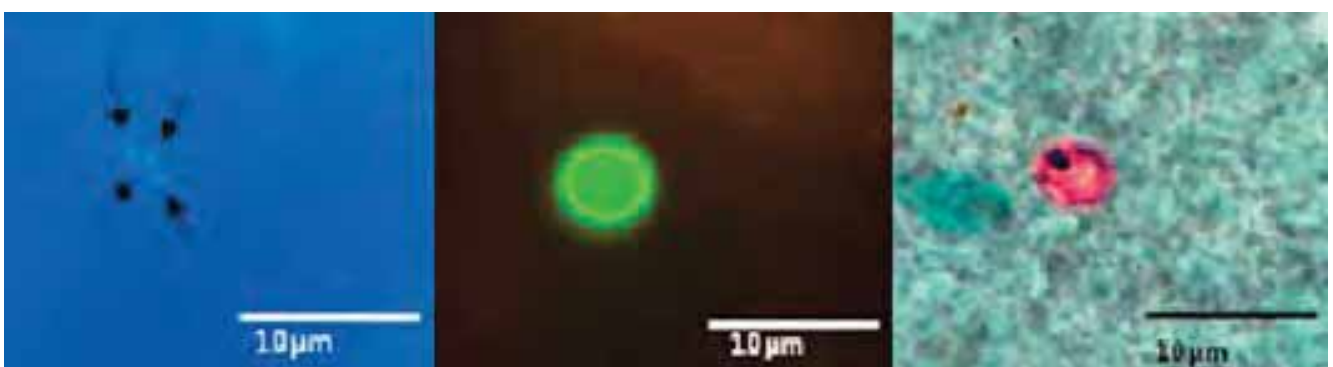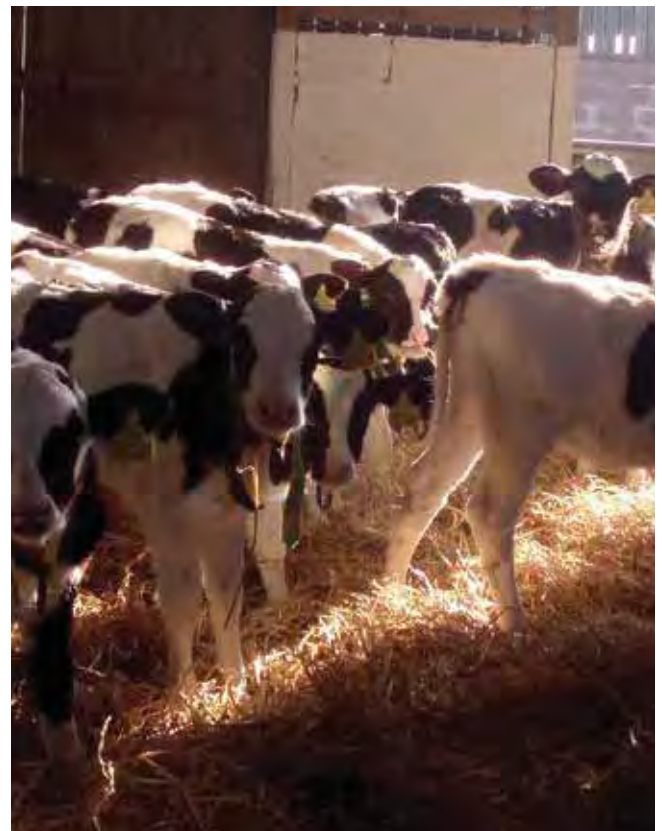
The effect of selection for lean tissue growth on muscle fibre characteristics in lambs, and the implications for welfare

Institute: Scotland's Rural College (SRUC)

Principal Investigator: Tamsin Coombs

Status: Completed

The problem

Lamb mortality rates in the UK range between 10-25% with highest rates of lamb death occurring on extensive hill farms where there is little opportunity for human intervention to prevent lambs dying. These high levels of mortality represent both a welfare and an economic problem for the industry, and are a barrier to sustainable lamb production. Recent research has shown that lamb survival is improved in lambs which stand and suck quickly after birth, and that breed differences in these behaviours exist, with consequences for lamb survival.

Why is work needed?

Pure bred Suffolk lambs, which have been selected for rapid lean tissue growth, show slower behavioural development at birth compared to relatively unselected pure bred Scottish Blackface lambs. In pigs and cattle, fast-growing genotypes have been shown to have a greater proportion of fast twitch compared to slow twitch fibres in their muscles.

Because of its reliance on anaerobic respiration fast twitch fibre types have the capacity to increase in diameter to a greater degree than slow twitch fibres, hence selection for rapid growth has favoured selection of animals with relatively more fast twitch muscle fibres than slow fibres.

The functional consequences for the animal of this change in muscle fibre type patterns have not been investigated; however the ability to maintain posture requires adequate numbers of slow, oxidative muscle fibres. It is possible that relatively unselected lambs will have a higher proportion of slow twitch muscle fibres than lambs of genotypes that grow rapidly, and this difference contributes to their improved neonatal vigour at birth.

It has also been shown that Blackface lambs are better able to maintain body temperature than Suffolk lambs, which supports the hypothesis of a difference in overall muscle fibre type balance between genotypes as metabolism in oxidative fibres will generate more heat.

The aim of this project was to investigate whether selection for rapid growth in pure bred sheep has altered muscle development by affecting the proportions of different fibre types and determine what effect this may have on the animal's ability to perform certain behaviours, such as neonatal progression to standing and sucking.

As muscle fibre development occurs very early in gestation (starting around day 32) it was also hypothesised that there may also be a relationship between muscle fibre characteristics, and foetal behaviour and presentation at birth. A further hypothesis to be addressed was that maternal undernutrition would have a greater negative effect on muscle fibre development in fast growing genotypes.

What was achieved?

It was found that pure bred Suffolk foetuses (fast growing genotype) were significantly less active at days 56 and 77 of gestation than pure bred Blackface foetuses (genotype relatively unselected for growth) while nutritionally restricted foetuses were more active at day 56 than control foetuses. A subsequent study found that foetal activity at day 98 was positively associated with neonatal activity. A relationship was also found between foetal activity and presentation at birth with malpresented lambs being less active as foetuses at day 77 of gestation than normally presented lambs.

Figure 1. Ultrasound scanning image of foetal lamb
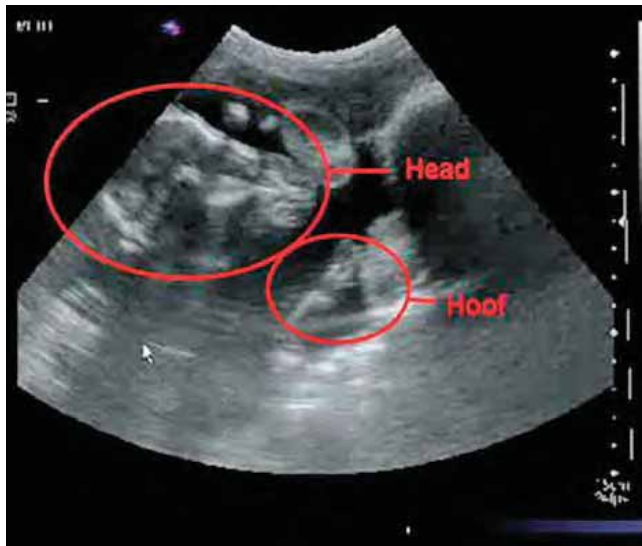
It was also found that Suffolk foetuses had lower proportions of slow twitch fibres and higher proportions of fast twitch fibres in the soleus (postural muscle) than Blackface foetuses and those animals that had lower proportions of SO fibres were less active at both days 56 and 77 of gestation.

Suffolk lambs also showed significantly slower neonatal behavioural development than Blackface lambs and there was an interaction between breed and nutritional treatment with prenatally undernourished Suffolk lambs consistently being less active and prenatally undernourished Blackface lambs being more active or reactive than all other groups of lambs.
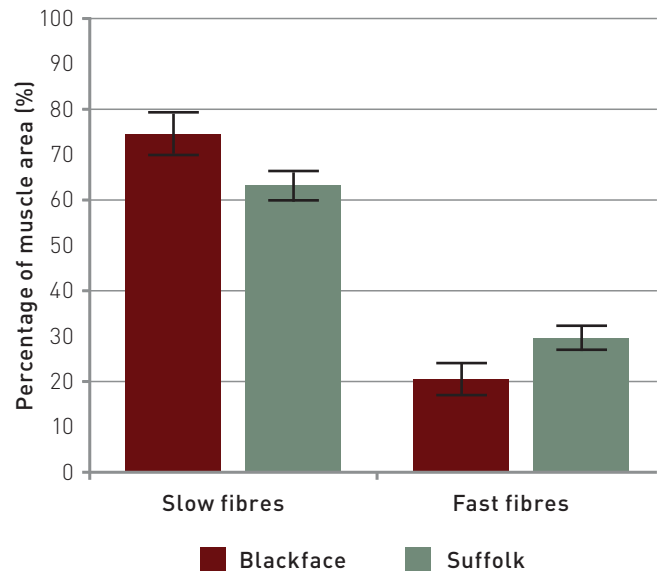
At slaughter Suffolk lambs had lower proportions of slow twitch and higher proportions of fast twitch fibres in the soleus muscle while also having a lower proportion of fast twitch fibres in the plantaris (muscle involved in movement of the limb) than Blackface lambs.

Slow fibre proportions in the soleus muscle were found to be positively correlated with total duration standing and walking in the early neonatal period while proportion of fast twitch fibres in the plantaris was negatively correlated with duration of lying laterally following birth. Interestingly within the Suffolk breed there was an indication that there was a relationship between activity and growth in some animals.

Benefits to industry

High levels of lamb mortality are a continuing constraint on efficient lamb production, and a welfare concern. The results from this study indicate that divergent breeding strategies have led to differences in muscle fibre proportions within certain muscles in sheep and also that there is a relationship between muscle development and both foetal and neonatal lamb behaviour. There is also an indication that it is possible to select for both increased activity and growth and this requires further investigation. It is also clear that the foetal period is crucial to the future development of the lamb and that nutrition in this period can have far reaching effects on muscle development, behaviour and future growth. It was also found that those animals that are at risk of malpresentation or suffering from neurological impairment can be identified from very early in gestation.

This study on pure bred sheep has highlighted some of the current consequences of selection for rapid growth on the function of the animal. The results support the need for the development of broader breeding goals which incorporate welfare and other characteristics. Further research is required to investigate whether the differences seen in muscle development and resulting differences in both foetal and neonatal lamb behaviour are also seen in cross-bred lambs.

The role of microRNAs and the host-parasite relationship in H. contortus

Institute: University of Glasgow

Principal Investigator: Henry Gu

Status: Ongoing

The problem

The growing human population has tripled the global demand for livestock products, such as meat, milk and wool in the past four decades and this demand is expected to double in the first half of the 21st century.

Gastro-intestinal (GI) nematodes that parasitize livestock pose a major health and welfare problem and are a threat to food security worldwide. These pathogens are responsible for significant economic losses incurred through morbidity and mortality as well as the decreased productivity and weight gain of the animals. A 2005 report estimated that GI parasites cost the UK sheep industry over £80 million per annum.

Control of GI parasites relies mainly on drugs called anthelmintics, which have been the primary method of controlling these parasites for the last 50 years. The discovery and utilisation of these drugs was swiftly followed by the emergence of anthelmintic resistance. The abomasal worm, Haemonchus contortus, was one of the first parasites reported to develop anthelmintic resistance. The continued absence of commercially viable vaccines has allowed GI parasites to become such a problem in some areas that farms have been abandoned and livestock culled.

The life cycle of H. contortus

Swallowed larvae develop into L4

Adult nematode in abomasum

L3 larvae ingested by host

Eggs passed onto pasture from faeces

L3 larvae in grass

L2 larvae in dung

L1 larvae in dung
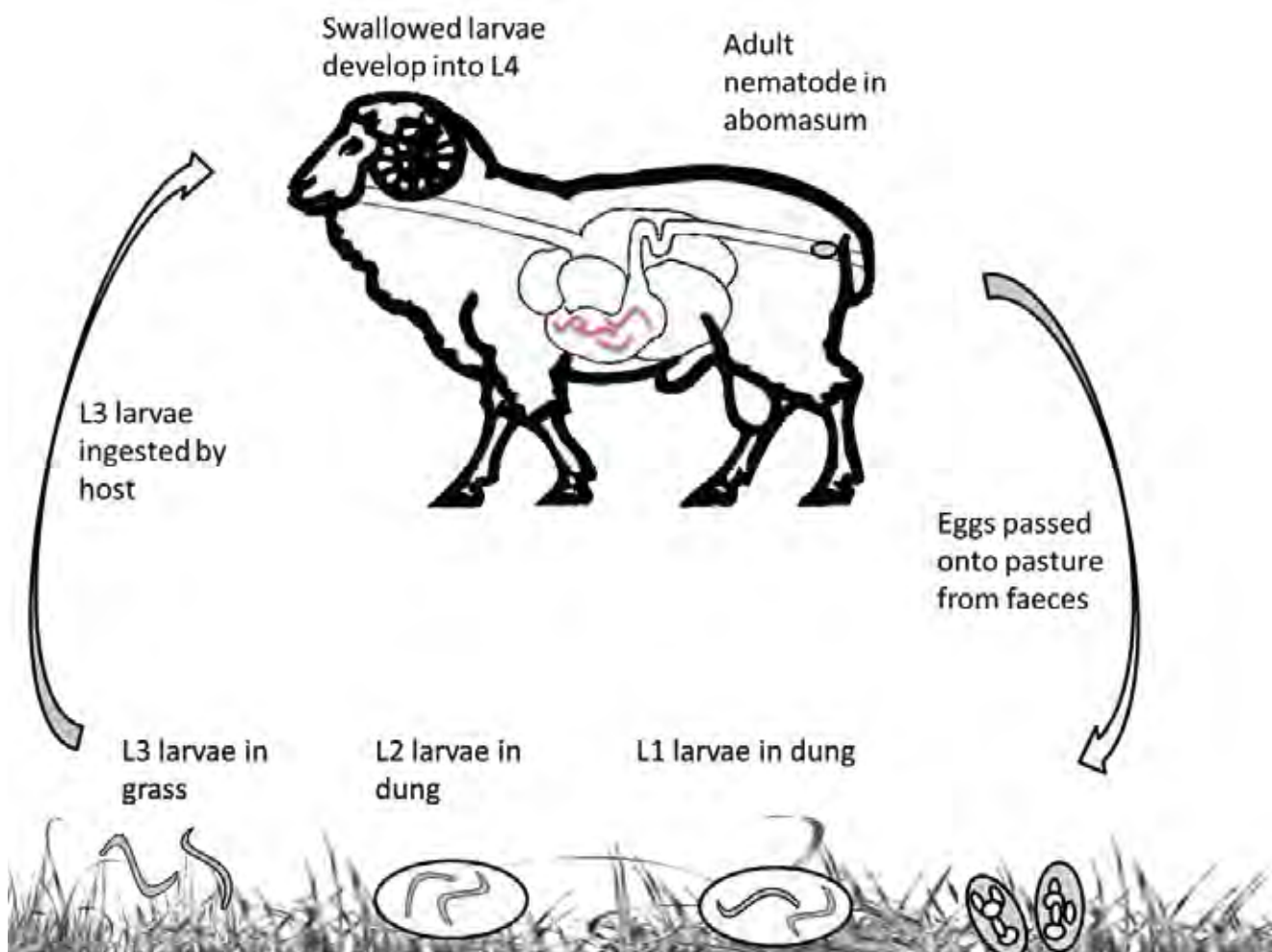
Why is work needed?

Anthelmintic drugs remain the major method of GI parasite control and whilst newer drugs are being developed, in time, resistance will develop against these drugs as well. Vaccines have the potential to be the most effective, long term method of control. However, while a number of molecules have been found that show promising levels of protection, so far these have only shown activity when purified from worms (native molecules). Attempts to recreate the molecules in a variety of expression systems from bacteria to the free-living nematode Caenorhabdites elegans, a close relative of H. contortus, have failed to yield the same protection levels as native antigens from the nematode.

GI nematodes are highly antigenic, yet natural immunity is slow to develop. This is thought to be due to the immunomodulatory effects of the nematodes. GI nematodes, such as H. contortus are able to excrete or secrete a variety of molecules into their host, collectively known as the excretory/secretory (ES) products. These products are known to reduce the effectiveness of the host immune system against the GI nematodes. Current understanding of the ES products has focused primarily on proteins. In this project, the aim is to determine whether small RNA molecules released by H. contortus affect the development of immunity.

What has been done so far?

MicroRNAs (miRNAs) are short sequences of RNA, around 22 nucleotides in length that are responsible for regulating the expression of target genes. It is estimated that the human genome encodes over 1000 miRNAs, which may target around 60% of mammalian genes. MicroRNAs were first discovered to be important in the development of the model nematode, C. elegans. Subsequently, a number of microRNAs were found to be conserved in many different species and several were shown to play roles in human diseases including cancer, heart disease and obesity.

In 2012, the presence of numerous microRNAs in H. contortus was confirmed. One particular miRNA, mir-5352, was found to be highly conserved only in nematodes that live in the GI tract and was not present in related nematodes that reside elsewhere. Further analysis of this miRNA showed that it is highly expressed during the stages when the nematode is in the host and that it is present in the ES products of H. contortus, suggesting a possible role in the host-parasite interaction. Bioinformatic tools identified possible mammalian targets, regulation of which could contribute to the immunomodulatory effects seen in nematode infections.

The initial studies have focused on collecting ES products from H. contortus and processing these for qRT-PCR. These experiments have confirmed the presence of the key miRNA of interest, mir-5352, in the ES. To develop this work further, we are studying the ES products of adult H. contortus to identify additional miRNAs. This will allow us to determine whether a subset of miRNAs is present in the ES, indicating selective secretion.

Experiments are also ongoing to investigate whether mir-5352 can be detected in abomasal and lymph node tissue dissected from sheep with or without H. contortus infections and to determine whether this molecule interacts with components of the immune response of the sheep.

Benefits to farmers

The project will identify the functions of secreted miRNAs, allowing us to better understand how H. contortus survives and modulates its environment. With a working knowledge of the role of miRNA in the host-parasite interaction, it may be feasible to selectively block certain miRNAs and thus potentially reduce the immunomodulatory effects of worm ES, improve vaccination and thus infection outcome.

RuminOmics: Connecting the animal genome, gastrointestinal microbiomes and nutrition to improve digestion efficiency and the environmental impacts of ruminant livestock production

Institute: Consortium led by University of Aberdeen

Principal Investigator: EU consortium led by John Wallace

Status: Ongoing

The problem

Ruminant livestock produce methane, a greenhouse gas with a global warming potential 25 times that of carbon dioxide. Methane comes from the action of the microbes in the rumen during the digestion of fibrous feeds, and it is mainly released into the atmosphere when the cow belches. The production of methane is not only important in terms of the environment, but it is also important in terms of livestock production and profitability because it is a waste of feed energy which varies between two and ten percent of total energy consumed by an animal.

Why is work needed?

If the amount of methane produced by ruminants can be lowered then there are benefits all round - for environment, for production and for profitability.

What has been achieved so far?

It was also known that diet can affect methane production, but currently most diets which have been formulated to lower methane, add cost or increase losses of other nutrients. For example, increasing dietary protein concentration reduced methane per kg milk output but at the expense of increased nitrogen losses, an outcome which impacts on both global warming and nitrogen pollution. Hence, the RuminOmics team is finding means to identify animals which are producing less methane and are more efficient across a range of diets.

The team is also exploring a hypothesis that the microorganisms in a ruminant's gut that form methane may be under the control of the animal itself, which would explain why some animals are consistently low emitters and others are high.

Using dairy cattle, the early studies have shown that the production of methane is quite variable particularly between individual animals. The finding has led the team to ask whether animals which are low emitters always emit low levels under all circumstances. Preliminary studies exploring this question using a group of 25 dairy cattle, suggest that irrespective of what the individual animals are fed, animals which are low emitters are always low emitters, and conversely cattle which are high emitters are always high emitters.

If the hypothesis is correct, it should be possible to breed for low methane emitters and, as a consequence, more feed efficient animals.

The main activity of the project involves more than 1,000 animals, which will be monitored for feed intake and methane emissions. These experiments are being done in England, Sweden, Finland and Italy. Subsequently samples from the animals will be characterised for genetic markers in order to find how these correlate with methane emissions. These huge datasets will ultimately be stored in a publicly available data warehouse. Anyone interested in animal breeding will then be able to use the results of the project.

In the meantime, shorter experiments are also being done to test the genetics/gut microbes/emissions relation. One of these involves the exchange of digesta between dairy cows and reindeer. Changes in methane emissions and the microbial community are being measured – will the bovine community change to one more typical of the reindeer?

The studies will test the commonly held notion that reindeer produce less methane than cattle. Preliminary results would suggest that this does not seem to be correct. Other short experiments to be carried out later in 2013 involve calf twins: if they are identical, and the animal controls the gut microorganisms, the calves should have the same microbial community.

Benefits to farmers

The outputs of RuminOmics will benefit farmers in terms of livestock production efficiency and hence profitability, as well as helping to reduce GHG emissions.

The RuminOmics concept

Emissions

Animal genetics

Ruminal microbiome
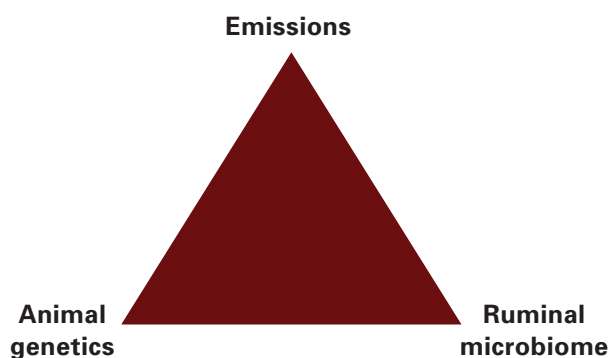
Identifying digital dermatitis infection reservoirs in beef cattle and sheep

Institute: University of Liverpool

Principal Investigator: Leigh Sullivan

Status: Ongoing

The problem

Lameness in sheep and cattle is a worldwide problem and a severe drain on the farming industry. One of the main causes of lameness is digital dermatitis (DD), an infectious hoof disease causing severe pain for the animals affected and a large loss in production for farmers. The primary cause has been identified as a bacterial agent known as treponemes. The disease can cause a loss in productivity in beef cattle and sheep through reduced reproductive capabilities and weight loss. There is no single effective treatment for the disease, and contradictory results of preventive controls. There is also little understanding of the routes of transmission of digital dermatitis, where the bacteria harbour and where the animals pick up the bacteria.

Why is work needed?

If the environmental and factors that influence the survival of treponemes are not known, it is not possible to develop means to reduce their prevalence in the farm environment. Without information on the carriage sites and how they are spread on farms, farmers will always be burdened with the disease with no way of knowing how to prevent the spread of the treponemes. Once this disease has made its way on to a farm, it is very difficult to eradicate and therefore more information on the transmission of this disease is urgently needed to stop it spreading within and between farms.

What has been achieved so far?

The digital dermatitis treponemes have been successfully identified in beef cattle lesions. This is important because to date little work has been carried out on these organisms. Different groups of treponemes have been identified in the lesions which will allow investigation of whether the treponemes in beef lesions are the same as in dairy cattle lesions. A large amount of sheep faeces has been collected, some from sheep suffering from Contagious Ovine Digital Dermatitis and some from sheep without the disease. This will allow comparison of the sets of faeces between the two groups. The treponemes isolated from these faeces so far have been healthy rumen treponemes, but the work will continue to study the faeces to see whether digital dermatitis treponemes may be passed via the faeces. Similar work is also being undertaken on beef faeces samples.

Environmental variables such as trimming equipment which may transfer treponemes from foot to foot will be studied to explore this possible route of transmission. Additionally, molecular techniques will be applied to rumen bacteria to see if treponemes, in particular digital dermatitis treponemes, were present and to investigate whether factors such as feed can affect the levels of treponemes in the rumen.

Benefits to farmers

The project will provide a greater understanding of the treponemes, their carriage sites and environmental risk factors associated with digital dermatitis lesions in beef cattle and sheep. This will lead to the development of better treatments and preventative measures which could range from environmental management to vaccines.

Digital dermatitis infection

Using stable isotopes to quantify C sequestration in managed grasslands

Institute: The James Hutton Institute

Principal Investigator: Lucy Marum

Status: Ongoing

The problem

Understanding soil carbon (C) is complex; the C within soil exists in a variety of forms all of which are cycled or turnover at very different rates. Some C associated with organic matter can be literally thousands of years old, whilst C associated with compounds released from living roots, root exudates, may have a very short residence time in soil, being rapidly used by the soil microbial population, the bacteria and fungi, within hours. Much of the C fixed by plants during photosynthesis is rapidly cycled through the plant-soil continuum; it can be thought of as 'C in and C out'. This is a large flux but has little net influence on the overall soil C content. However, a smaller proportion of C does contribute to the long term storage within the soil, and can become part of the soil organic matter. This component is intrinsically linked to the quality of the soil, its nutrient status and importantly its productivity in a managed grassland system.

Increasing levels of atmospheric carbon dioxide (CO_2) are linked to climate change, and across Europe measures are being taken to reduce CO_2 emissions.

The Scottish Government has set an ambitious target of a 42% reduction in carbon emissions by 2020. Greenhouse gas inventories for agriculture on a UK-wide basis are currently calculated using default values and are recognised to lack detail in terms of country-specific emissions factors that reflect regional conditions such as climate, soil quality and farming practices. There is a commitment from the UK Government Climate Change Committee to address this and provide better inventory values. Grasslands play an important role here and represent a significant land cover across the UK; therefore any small change in C storage, such as a net gain will have a large impact on this C inventory and help offset C emissions. Finding ways to increase soil C storage not only helps mitigate rising atmospheric CO_2 levels, but importantly improves soil quality, so represents a win-win scenario. Measuring net gains or losses in soil C status is surprisingly difficult and typically uses repeated sampling over many years, and so understanding the impacts of different management regimes on long term soil C stocks is not straightforward.

Why is work needed?

This project aims to use small natural changes in the stable (non-radioactive) isotope ^{13}C, to try and measure current soil C status in managed grassland and provide an indication as to whether they are gaining or losing C. This technique relies on analysing the CO_2 which is continually generated within the soil and released from the surface. This CO_2 efflux comes from two main sources. One is the roots of the plants and the microbial community living close by, and is known as autotrophic respiration. This constitutes the 'C in and C out' flux. The second component comes from the turnover and processing of soil organic matter. This heterotrophic flux, as it is called, is important because it is this flux which can indicate whether a soil is gaining or losing C. Increases in this flux without more C coming into the system could mean an overall loss of C from the soil. The soil surface efflux has two parts, the autotrophic and heterotrophic fluxes, and by using isotopes this flux can be partitioned and the overall C status of a soil can start to be assessed.

What has been done so far?

This technique has been previously applied to mainly forested systems and moorlands, but little work has been conducted in managed grasslands. This project will take existing protocols and adapt them to grasslands. Initial work will use grass grown under controlled conditions to test a new chamber system and begin to calibrate a field portable isotope analysis system, called a wavelength scanned cavity ring-down spectrometer.

Because this technique relies on measuring relatively small differences in ^{13}C isotope content, the equipment used has to be optimised and existing laboratory-based stable isotope mass spectrometers are being used to achieve this. A number of field sites are being evaluated in readiness for sampling campaigns planned over the growing season; sites with known grazing histories and different management regimes will be selected.

Benefits to farmers

Ultimately, this work seeks to provide farmers with guidance on how grasslands might be managed in order to increase soil C levels. Although the type of soil on the farm has an overarching influence on the soil C stock, the work here will provide information on how to protect soil C and the means by which soil C can be maximised in specific situations.

Breeding grasses and clovers for the future

Institute: IBERS Aberystwyth University

Principal Investigator: Athole Marshall

Status: Ongoing

The problem

A number of factors such as increasingly variable weather patterns, the increasing price and reducing availability of fertilisers and concerns on the environmental impact of livestock production may impact on the productivity of grassland.

Why is work needed?

One way to approach the issues of variable rainfall, temperature and nutrients is to breed new grass and clover varieties which may be able to use nutrients more efficiently and that have improved growth under conditions of variable rainfall. These characteristics offer important benefits to farmers reliant on grazed and ensiled grass and clover leys, providing not only improved production benefits but also reducing losses of nutrients.

What has been achieved so far?

Four linked pieces of work are being undertaken:

1. Genetic improvement of forage grasses and white clover to improve phosphorous use efficiency (PUE) and reduce phosphorous losses to water from UK grasslands.
   This work is focused on the development of new grass and clover varieties with much lower phosphorous (P) requirements. This is important because not only is phosphorous a major polluter of water courses but sources of phosphorous fertiliser are limited and there is no synthetic alternative that could be used to replace natural phosphorous. So far perennial ryegrasses and white clover varieties that grow well in moderate and low phosphorous conditions have been developed using flowing solution culture and are currently undergoing testing in soils of both low and normal P status prior to being entered into National List trials.

2. Genetic improvement of perennial ryegrass and red clover to increase nitrogen use efficiency and reduce N losses from pastures and silo.
   This work is focused on the development of both grass varieties with enhanced nitrogen uptake and use efficiency and on the development of red clover varieties that leach less nitrate into the ground water than currently available varieties. A new low nitrate leaching line of red clover has been developed and

is being grown in field experiments to look at leaching in comparison to 'normal' red clover varieties. Breeding perennial ryegrass varieties that are capable of using fertiliser inputs more efficiently should lower recommended application rates and reduce nitrogen leaching. This part of the project is also looking at ways to reduce nitrogen losses in clovers when they are ensiled. Variation in activity of the enzyme polyphenol oxidase (PPO), which protects protein from breaking down, has been identified between and within red clover varieties which will enable selection of new red clover varieties with appropriate levels of PPO to reduce N losses.

3. Genetic improvement of perennial ryegrass and white clover to increase the efficiency of nitrogen use in the rumen.
   This work is focused on increasing nitrogen use in the rumen when ruminants graze perennial ryegrass and white clover. The perennial ryegrass breeding programme is targeting an 8% increase in water soluble carbohydrate (WSC) compared to commercially available varieties. Parallel work is also aiming to breed white clover varieties with 5-10% lower leaf protein than 'normal' varieties, with the overall objective of improving the efficiency of rumen function. So far the results have delivered three new AberHSG (High Sugar Grass) diploid perennial ryegrasses (Figure 1), which are currently undergoing National and Recommended List trials. It is anticipated that the first AberHSG variety with this added benefit will be launched in 2014. The novel lower protein white clover has been developed and is currently being grown in field trials alongside a typical white clover to quantify impact of reduced protein content on feed intake, milk production and N excretion when fed to ruminants with high sugar grasses. This low protein white clover variety has recently been entered into National List trials. In the future it is hoped that this work will benefit farmers through more grass per kg of fertiliser plus even more meat and milk production from forage fed animals (Figure 2).

4. Development of productive and persistent high quality forage grasses and white clover with increased water use efficiency and resilience to summer droughts. This part of the work is aimed at improving water use efficiency and drought tolerance of perennial grasses and white clover (Figure 3). Variation in rainfall patterns is increasingly evident and in many parts of the UK average rainfall is lower than the 1961-1990 long-term average. Perennial ryegrass production is reduced by 1 tonne/hectare for every 50mm increase in soil water deficit (typically a reduction of 2-4 tonnes/ha/yr in the UK). Ryegrass x fescue species' hybrids offer the opportunity to combine good forage production and quality with improved persistency and stress tolerance. So in this part of the project, the use of marker assisted selection techniques has enabled the transfer of improved drought tolerance from fescue species firstly into Italian ryegrass and now into perennial ryegrass as a way of improving the drought tolerance of these important grass species. New drought tolerant ryegrasses provide forage production and quality equivalent to current ryegrass varieties under non-stress conditions but significantly greater yields and recovery under prolonged summer droughts. The new ryegrass x North African or Mediterranean fescue species' hybrids are fertile and highly productive with large extensive root systems and provide potential for sustained future grassland agriculture should water availability be reduced to levels significantly greater than are found in the UK today.

Selection for drought tolerance has also been achieved in white clover and the relationship between root architecture and ability to tolerate soil moisture deficit is being examined. Variation in water use efficiency and drought tolerance within white clover is closely associated with differences in root architecture providing valuable information that will enable incorporation of drought tolerant traits into new white clover varieties. New hybrids between white clover and the rhizomatous species Caucasian clover are more drought tolerant than white clover at comparable levels of soil moisture deficit providing options for sustainable forage production in periods of summer drought.

As well as the novel traits of interest all new varieties are being tested for the important agronomic traits to ensure they combine the yield and quality traits demanded of a modern grass, white or red clover variety. Already new varieties from this work have entered national and recommended list trials.

Benefits to farmers

The results of these projects should provide farmers with grass and clover varieties better suited to high productivity under conditions of variable rainfall and lower nutrient availability.
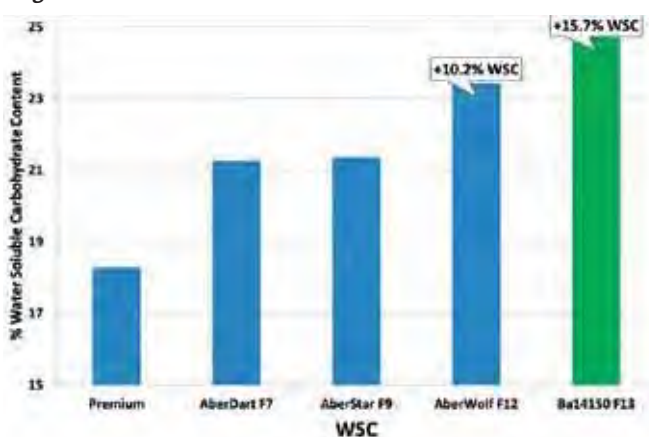
Figure 1:

Figure 2:

Figure 3:

Ecology of cryptosporidium (aligned to the CRYPTOBEEF project)

Institutes: The James Hutton Institute; Moredun Research Institute

Principal Investigator: Rupert Hough

Status: Ongoing

The problem

Cryptosporidium – or "Crypto" – is a single-celled parasite that invades the cells lining the intestine of a wide variety of animals. Crypto causes diarrhoea, weight loss (and death) in cattle, sheep, and goats. It has important implications for public health as the same organism can cause illness in humans.

Studying survival of Crypto in the environment is problematic, and there are a number of barriers to success. Current molecular techniques cannot identify whether an organism is viable, which may lead to spurious results. Also, the oocysts are readily mobilised during rain events. This can result in rapid declines in oocyst numbers for a given location while not necessarily being indicative of die-off. Presence of oocysts at the pasture surface may present a source of infection for cattle and is likely to be controlled by the extent of surface run-off and percolation into the soil.

Soil structure has a major influence on filtration of particulates (including pathogens) during percolation of surface water through the soil column and, alongside vegetation cover, during overland flow. Furthermore, soil wetness class (the presence of free water or a water table in the soil) has been shown to influence the transport of pathogens from soils to watercourses.

Why is work needed?

There are limited veterinary control measures and the organism is very resistant to environmental stresses. Little is known about how Crypto spreads and how neighbouring farms or those following similar management practices vary in terms of Crypto infections. Environmental factors such as soil moisture content have been implicated in Crypto survival, but evidence is limited. We hypothesise that soil physical characteristics will play a significant role in determining the persistence of Crypto oocysts on pasture, thus influencing exposure of cattle to the organism and having implications in the on-farm transmission pathways.

This project aims to produce some of the first Scotland-specific data on the persistence and survival of Crypto in the soil environment under field conditions.

What has been achieved so far?

A sub-set of farms from last year's CRYPTOBEEF project has been selected based on the soil types present. Soil wetness class is related to both inherent soil properties and management practices. It is divided into six categories, and we have selected CRYPTOBEEF farms in order to cover the full range of categories.

The main periods for Crypto infection are in the spring (April/May) and during late summer (August), and it is planned to carry out the fieldwork during these times. Sites of each wetness class with likely high loading of faecal oocysts will be identified (e.g. calving fields which have recently been in use) and small plots fenced off from further cattle access. Crypto counts will be determined at each site by direct DNA extraction and qPCR. Soil characteristics will also be determined. Return visits will be made to a sub-set of sites with high initial Crypto counts, and these will be monitored over time. Where possible, surface run-off will also be monitored (e.g. where there is evidence that surface material is likely to enter farm drains and ditches, using large volume cross-flow filtration. This will provide an estimate of oocysts lost to run-off.

In addition, Cryptosporidium monitoring cages will be sunk into the soil at the selected sites. These chambers have a semi-permeable membrane with a pore size that allows exchange of water and gases, but do not allow oocysts to cross the membrane. Cages will be spiked with a known number of viable oocysts and will be sampled at regular intervals to determine their viability.

Benefits for farmers

The final output will be the relationship between soil wetness class and Crypto survival. This will provide an indication of soil types (and hence fields) where Crypto persistence is likely to be lowest and thus most suitable for calving and running calves but will also identify soil classes which may present a risk of spread of oocysts to the wider environment. This information will allow farmers to identify best practice use of fields with respect to both aspects.

Using novel nitrate sensors to improve the efficiency of nitrogen use on livestock farms

Institute: University of Bangor

Principal Investigator: Rory Shaw

Status: Ongoing

The problem

A large proportion of nitrogen in fertilisers and manures is lost to the environment during and following application. This represents an economic loss to the farmer. Loss of nitrogen to the environment can cause significant pollution, especially in surrounding water where nitrate from diffuse agricultural pollution can contribute to eutrophication – the process where bodies of water receive excess nutrients which stimulates excessive plant and algal growth. Emissions of gaseous nitrogen from soil are increased by fertiliser additions and contribute to global warming.

Figure 1: A lake suffering from eutrophication

Why is work needed?

Nitrate is the most important source of N for crop plants in most agricultural environments. Its concentration in the soil is very dynamic and changes quickly in response to fertiliser and manure inputs, changes in the weather and crop uptake.

For all farmers, management and use of fertilisers is important, especially for those farms within Nitrate Vulnerable Zones (NVZs) which face restrictions on fertilisers and manure use. Hence it is important to be able to apply fertilisers efficiently and to meet the soil requirements for nitrate. However, current methods of testing soil nitrate concentrations are costly, time consuming and give poor temporal resolution. This makes calculation of accurate fertiliser applications difficult and there is a need for new, faster measurement systems.

What has been achieved so far?

The aim of this study is to investigate how real time in-situ nitrate sensors may improve the efficiency of nitrogen inputs. The sensor consists of an electrode which is attached to a data logger. The electrode can be placed into soil or water and the nitrate concentration recorded continuously over a period of time (Figure 2).

The sensor may be coupled with a wireless device to allow remote monitoring. The nitrate electrode is an ion selective electrode and works just like a pH probe. The electrode gives an output in volts, which is related to the concentration of nitrate in the soil solution. Calibration of the electrodes before use allows the voltage output to be converted into nitrate concentration.

Sensor systems are currently being tested and characterised in the lab with the hope that field trials will start in the spring/summer. The plan is to investigate the effect that different clover densities has on the nitrate dynamics of the soil.

Figure 2: Nitrate sensor and data logger

Benefits for farmers

Continuous monitoring of soil nitrate concentration may allow more accurate application of nitrogen fertiliser. The sensors will improve knowledge of nitrate dynamics in a range of agricultural systems and fertiliser regimes. This may allow improvements to be made to fertiliser recommendations and models used by farmers.

Using Computed Tomography (CT) to select against waste while improving taste

Institutes: Scotland's Rural College (SRUC)/University of Edinburgh

Principal Investigator: Neil Clelland

Status: Ongoing

The problem

One of the main drivers influencing consumers at the point of purchase is the level of visible fat associated with lamb. Consumers often perceive lamb as a fatty meat in relation to that of beef and pork. This, coupled with the meat processing industry preference for a reduction in carcase fat, increasing lean meat yield and reducing waste during processing, has led to continued intense selection for increased lean growth and reduced fatness in sheep, similar to historical selection practices in pigs which resulted in a reduction of overall fatness compromising flavour and tenderness in pork.

The relationship between meat eating quality traits (e.g. tenderness, juiciness) and fat levels in the muscle is a matter of debate, although it is well accepted that there is a relationship between fat and flavour. However the relationship between carcase fat (CF, fat between muscles and including subcutaneous fat) and IMF is genetically highly positively correlated (i.e. carcases with high levels of carcase fat also have higher intramuscular fat). This evidence suggests that continued intense selection for leaner carcases in the sheep industry will result in a reduction of IMF and in turn this will have an adverse impact on the flavour and possibly the juiciness of lamb. There is some evidence that it may be possible to select against CF whilst maintaining levels of IMF, therefore it may be possible to maintain flavour whilst reducing carcase fat.

Why is work needed?

CT scanning is a routine measure used in several selective breeding programmes for sheep in the UK. It provides the potential to quantify both CF and IMF (and potentially other meat quality traits) in living animals at the same time.

It is important to understand whether additional meat and carcase quality parameters can be assessed using CT, and whether these predictors can also be incorporated into breeding programmes, so allowing continued improvements in growth and carcase composition, whilst maintaining flavour aspects of quality.

What has been achieved so far?

The project is using a large amount of data and is currently using data collected from 449 Texel lambs. These data will be used to develop the best method for analysing the CT images to predict intramuscular fat levels in the loin and to assess the resulting genetic parameters for their use as predictors of meat quality in breeding programmes. Across breed comparisons will also be explored.

Live lambs were CT scanned at three reference sites across the carcase (Ischium, 5th lumbar vertebra and 8th thoracic vertebra) and, following slaughter and dissection, IMF was measured in the loin.

8th thoracic vertebra *5th lumbar vertebra*

Ischium
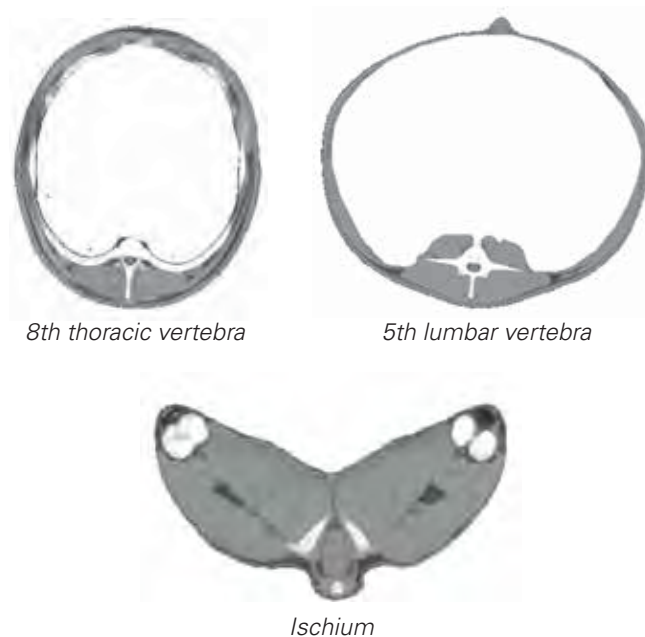
Pure bred Texel lambs of both sexes (female and entire males) were produced over three separate years (2003, 2004 and 2009). Age at slaughter ranged from 99 days to 234 days with an average age at slaughter of 149 days and live weight at slaughter ranged from 19.7kg to 52.2kg with an average weight at slaughter of 34.33kg. Carcases were subjected to high voltage electrical stimulation, chilled for between 7-9 days and dissected, removing the loin muscle from the right side of the carcase which were vacuum-packed and frozen. The muscle samples were then thawed, cooked in vacuum-pack bags 'sous-vide' at 80°C to an internal core temperature of 78°C. Samples were then cooled in ice and held at 4°C. Shear force was measured using a TA-XT2 texture analyser. IMF analysis was performed using petroleum ether in a Soxhlet extraction, and results averaged.

The first part of the study investigated the use of combined information from the two dimensional reference scans as predictors of IMF.
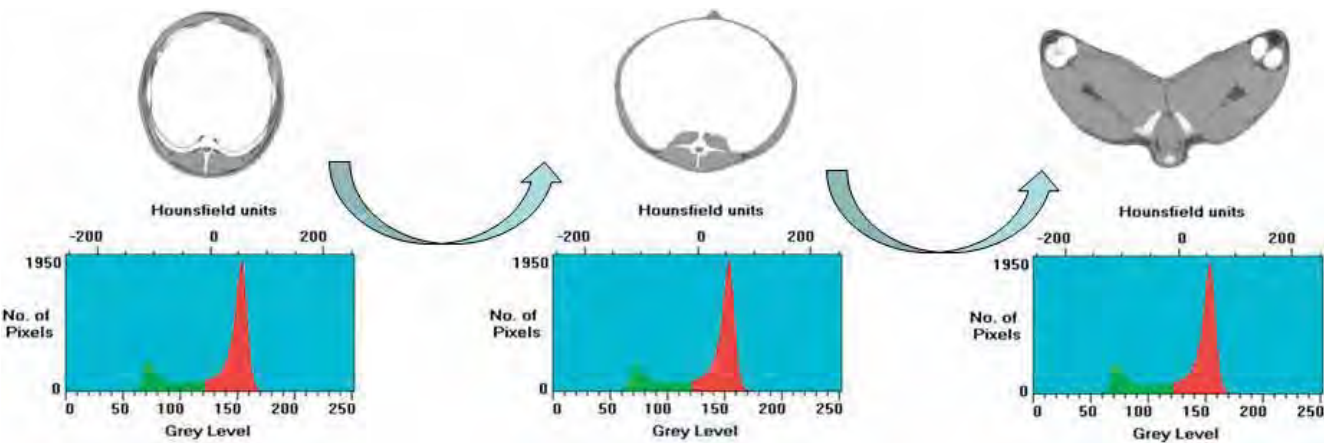
The results in Table 1 and 2 are presented using the adjusted R^2 and residual mean square error (RMSE), the adjR^2 provides a percentage of the accuracy in the model (i.e. the higher the percentage the more accurate a predictor the model will be), a model closer to 1 (explaining 100% of the variation) is considered a more accurate predictor than a model closer to 0 (i.e. 0.10 explaining only 10% of the variation). RMSE is the average error that may occur in the resulting prediction when using the model. The target for such a prediction model being a high R^2 and a low RMSE (in relation to the predicted measurement). The results showed that muscle density measured in the live CT scans is a good predictor of IMF%, however the prediction accuracy may be improved by including multiple variables from the CT scan information obtained, such as fat density and variation in fat and muscle density across the scan image.

Muscle density alone was able to predict 38% of the variation in IMF in the loin from all three reference scans with the accuracy of prediction increasing to 63% when further information from both fat and muscle density was included.

A novel measure combining the density measurement and variation of both muscle and fat was also investigated which was able to predict 60-61% of the variation in IMF.

Table 1: Linear regression models between IMF and CT tissue density parameters, with adjusted coefficient of determination (R^2) and residual mean square error (RMSE). MD – muscle density; FD – fat density; MSD – ; FSD – ; STD – ; STSD – .

Model	Ref[1]		LV5[2]	
	Adj R^2	RMSE	Adj R^2	RMSE
A-MD	0.38	0.55	0.24	0.61
B-MD+MSD	0.55	0.47	0.51	0.49
C-FD	0.39	0.55	0.04	0.69
D-FD+FSD	0.45	0.52	0.13	0.65
E-MD+MSD+FD+FSD	0.63	0.43	0.55	0.47
F-STD	0.60	0.45	0.53	0.48
G-STD+STSD	0.61	0.44	0.53	0.48

[1]Using data from all 3 reference scans. [2]Using data from the LV5 scan only

Using the same model progression virtual dissection of the loin was then considered on a smaller subset of the original data using 100 animals. Removing carcase portions of the LV5 image concentrating the information to an area of interest associated more with the region of the loin from which IMF was chemically extracted, firstly in the whole loin area (dissect[1]) and then in the single loin muscle (dissect[2]).

Virtual dissection of the loin area/muscle
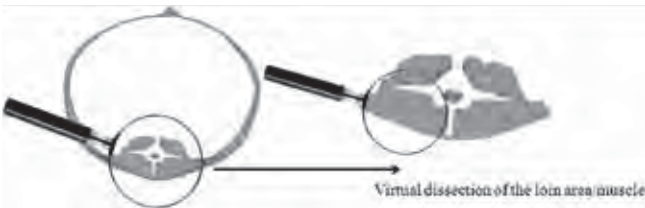
Table 2: Linear regression models between IMF and CT density with coefficient of determination (R^2) and residual mean square error (RMSE), based on a subset of data

Model	LV5[1]		dissect1[2]		dissect2[3]	
	Adj R^2	RMSE	Adj R^2	RMSE	Adj R^2	RMSE
A	0.51	0.50	0.22	0.63	0.31	0.60
B	0.55	0.48	0.29	0.60	0.43	0.54
C	0.05	0.69	0.03	0.71	*	0.72
D	0.45	0.53	0.03	0.71	0.06	0.69
E	0.59	0.46	0.30	0.60	0.48	0.52
F	0.54	0.48	0.23	0.63	0.29	0.60
G	0.56	0.47	0.22	0.63	0.29	0.60

[1]Data from LV5 scan only [2] Data from loin area scan only [3] Data from right side loin muscle only

8th thoracic vertebra

The results from the virtually dissected CT data showed that there is no improvement in the prediction accuracies of the models tested on IMF percentage in the loin, in fact there is a marked decrease in the prediction accuracies when information from a more defined region of interest is used in the models. Prediction accuracies dropped in the model with the highest accuracy, from 59% accuracy to 22% and 29% respectively in the dissect[1] and dissect[2] analysis.

Currently the project is investigating the use of spiral CT information across the whole loin region, using CT information from approximately 24 scans across the loin region using the same model progression as previous analyses, after which models will be assessed and compared for accuracies leading to the selection of the most accurate model in the prediction of IMF% in the loin.

Benefits to farmers

The benefit of this research would be the establishment of informative estimated breeding values for both intramuscular fat (and potentially other meat eating quality traits) and carcase fat, and balancing the selection of lean carcase growth without compromising meat eating quality in breeding programmes.

Liver fluke – improved diagnosis and detection of resistance

Institute: Moredun Research Institute

Principal Investigators: Philip Skuce and Ruth Zadoks

Status: Ongoing

The problem

The summer of 2012 was one of the wettest on record and, as anticipated, liver fluke has become a major problem for livestock farmers with a 10-fold increase in diagnoses of acute liver fluke disease in the last quarter of 2012 compared to the previous year. In addition, rumen fluke has emerged as a cause of clinical disease in cattle and sheep, with as many diagnoses of rumen fluke in 2012 as in the previous five years combined.

The 'summer' of 2012 © Moredun Research Institute

Why is work needed?

To be able to address many of the current difficulties with fluke infection there is a need for a major effort in developing diagnostic tests for detection of juvenile fluke and differential diagnosis between liver fluke and rumen fluke. There is also a need to invest in a large knowledge exchange effort to help the industry deal with the current crisis.

What has been achieved so far?

Liver fluke: Faecal samples have been collected and processed from sheep (25 farms, 805 samples) and beef farms (seven farms, 188 samples) to assess the usefulness of the new faecal (or copro-) antigen ELISA (cELISA) test in a large field sample.

Detailed statistical analysis and mathematical modelling is ongoing but results to date clearly show that a proportion of faecal samples with liver fluke eggs give a negative test by cELISA for both sheep and cattle. Thus, cELISA is not the improvement that had been hoped for in liver fluke detection.

However, the cELISA provides a faster means of evaluating treatment outcome than faecal egg count (FEC) in established infections. In addition, the studies showed that the liver fluke cELISA does not cross-react with rumen fluke and that it may be useful on farms with both fluke species.

Meanwhile, DNA-based methods for detection of liver fluke are appearing in the scientific literature and because of limitations of the cELISA, the work has moved on to evaluating the potential usefulness of fluke DNA in clinical diagnostics, particularly for the detection of the juvenile flukes that cause acute liver fluke disease.

Adult liver fluke escaping from the bile ducts of a lamb at post mortem. © Moredun Research Institute
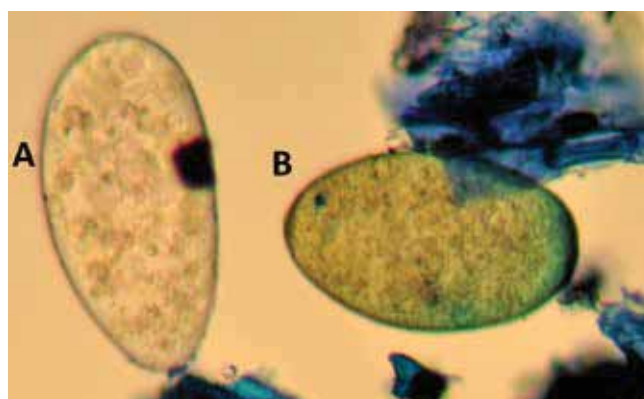
Fluke eggs extracted from cattle faeces: rumen fluke (A) and liver fluke (B). © Moredun Research Institute

Rumen fluke: For decades, it was assumed that the main rumen fluke in the British Isles was Paramphistomum cervi, a parasite that is associated with deer and with aquatic intermediate snail hosts. This had never been confirmed with modern DNA-based methods.

Using material from the sheep postal survey, cattle faeces and clinical specimens provided by AHVLA, SAC Vet Services and R(D)SVS, the species identity of rumen fluke in Scotland has been determined.

Very surprisingly, all samples were shown to be Calicophoron daubneyi, the major rumen fluke species of livestock in mainland Europe. It was thought that this species might occasionally occur in imported livestock, but the results clearly demonstrated its presence in homebred Scottish cattle and sheep.

The species name matters because C. daubneyi has the same intermediate host mud snail as the liver fluke, which means that rumen fluke may become as widespread as liver fluke, particularly if prevailing weather patterns continue.

Disease due to rumen fluke is rare, but rumen fluke may be important in the context of liver fluke diagnostics. Rumen fluke eggs look similar to liver fluke eggs and their presence may lead to incorrect diagnosis of liver fluke infection or treatment failure based on FEC, which emphasises the importance of new diagnostics for liver fluke.

On a cattle farm where rumen fluke was present and considered to cause disease, the effect of treatment was evaluated. Using a faecal egg count reduction test (FECRT) for rumen fluke eggs, oxyclozanide treatment was shown to eliminate rumen fluke infection with subsequent improvement in general condition of treated animals. This is good news for farmers who have animals affected by rumen fluke.

Benefits to farmers

The identification of the type of rumen fluke present in Scotland and the demonstration that it can be eliminated by oxyclozanide treatment is good news for farmers who have animals affected by rumen fluke.

Adult rumen fluke on the surface of a cow's stomach. Image kindly supplied by Rachael Morris, AHVLA, Starcross, Devon © crown copyright
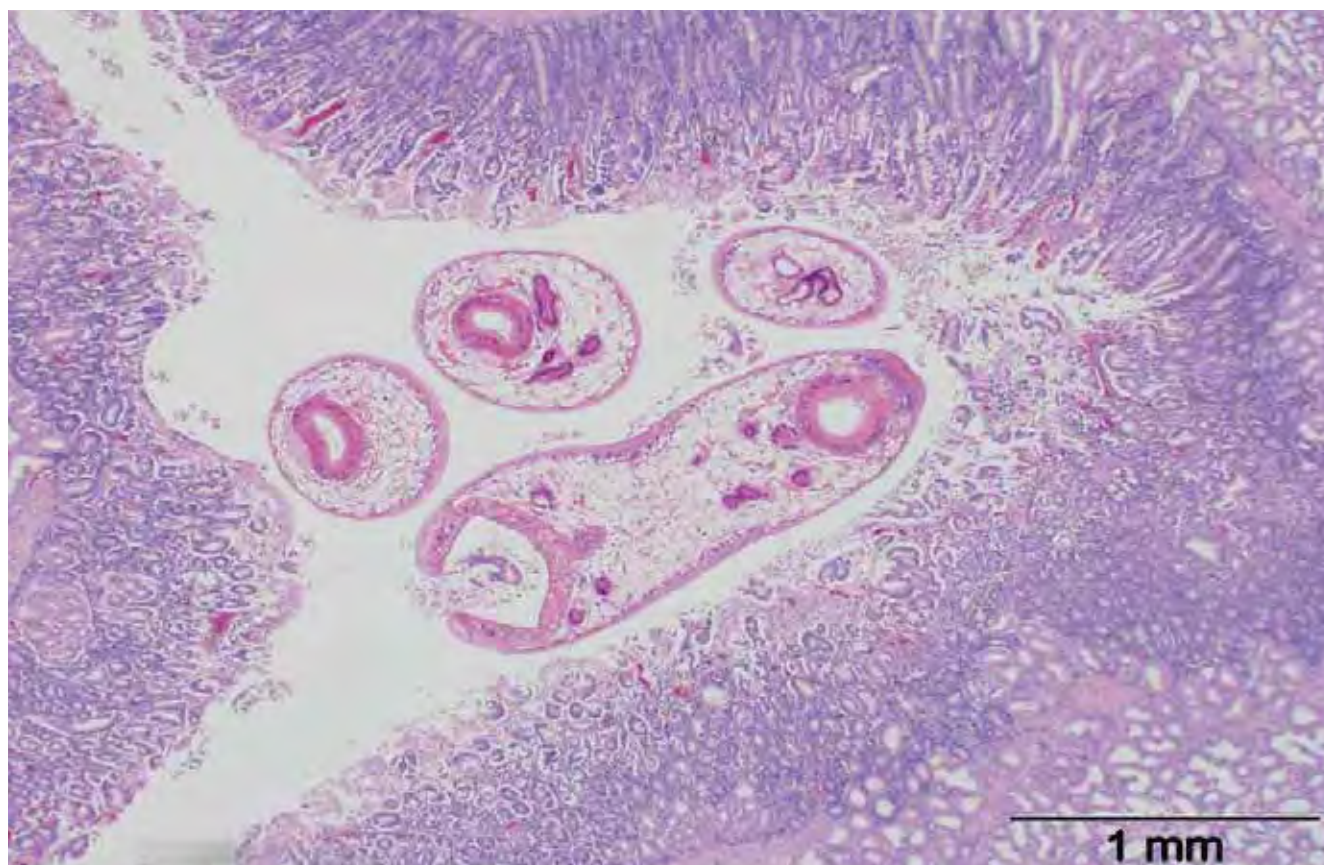
Tissue section showing immature rumen fluke in the intestine of an infected cow © Moredun Research Institute

MONITOR FARMS PROGRAMME

INTRODUCTION

As with any business, change is inevitable and in farming it is important to be able to manage this change by taking the time to review your enterprise, looking at comparable enterprises and assessing new opportunities. Hearing recommendations from different sources, discussing options with valued opinion leaders and seeing practical examples in the field provide farmers with the ability to make an informed judgement on business decisions.

This approach to sharing ideas lies at the heart of the Monitor Farm programme, a Scotland-wide network of ruminant, pig, dairy and arable farms, led by farmers for farmers, to help improve productivity and most importantly farm profitability. The programme gives each Monitor Farmer the opportunity to adopt and develop new ideas with the support of the local group of farmers and expert advisors.

The Monitor Farm reports printed in this publication give a brief summary of the farms and the topics covered in 2012/13. Each also highlights a specific topic which the Monitor Farmer, working with the community group and facilitators, has focused on in more depth. Each meeting held on a Monitor Farm is reported and there is a wider range of subjects available at www.monitorfarms.co.uk. If you would be interested in attending a meeting at one of the current farms, please contact the facilitators listed on the website.

The Monitor Farm programme receives support from the Scottish Government Skills Development Scheme and from others including QMS, NFUS, SOPA, CNPA, HGCA and a range of local sponsors. Project co-ordinators are listed in the table below.

Scottish Monitor Farm Programme – meeting reports are available at www.monitorfarms.co.uk				
Farm	**Project Co-ordinator**	**Project End**	**The Challenge**	**Page**
Aberdeenshire Organic	SOPA	Spring 2014	Further information is available at www. monitorfarms.co.uk or www.sopa.org.uk	n/a
Borders Arable	HGCA	Spring 2014	Further information is available at www. monitorfarms.co.uk or www.hgca.com	n/a
Cairngorms	QMS	Winter 2014	Forage crop establishment	57
Caithness & Sutherland	QMS	Spring 2013	Improving suckler herd fertility	59
Central Dairy	QMS	Spring 2013	Improving feed efficiency and milk yield	61
Clyde	QMS	Winter 2015	Managing pneumonia in calves	64
Dumfries (Beef Finishing)	QMS	Winter 2015	Understanding and meeting processor requirements	68
Forth	QMS	Winter 2015	Comparison of selling cattle store or finished	72
Kintyre	QMS	Spring 2014	Rationalising the sheep enterprise without sacrificing productivity	75
Moray and Nairn	QMS	Summer 2013	Is a calf from every cow possible?	77
Mull	QMS	Spring 2014	Adding value to hill lambs	80
North East Arable	HGCA	Summer 2014	The cost of producing a tonne of grain	82
Peeblesshire	QMS	Winter 2015	Finishing lambs indoors efficiently and profitably	84
Pig	QMS	Winter 2015	Identifying and improving on factors limiting production	86
Orkney	NFUS	Summer 2015	Improving daily live weight gains in cattle during the grazing season	88
South West Dairy	QMS	Spring 2013	Further information is available at www. monitorfarms.co.uk or www.dairyco.org.uk	n/a
New Monitor Farms in 2013 – farm details and reports will be available at www.monitorfarms.co.uk				
Farm	**Project Co-ordinator**	**Project Launch**	**Comment**	
Dairy Central	DairyCo	Summer 2013	Further information is available at www.dairyco.org.uk	
Dairy South West				
Easter Ross/Moray Coast Arable	HGCA	Autumn 2013	Further information is available at www.hgca.com	
Fife Arable				

CAIRNGORMS MONITOR FARM

Date of first meeting: November 2011

Name of Monitor Farm: Cairngorms Monitor Farm

Farmers' names: George & Charles Gordon

Farm name: Lost

Address: Strathdon, Aberdeenshire

Postcode: AB36 8UQ

Ownership: Tenant Farmers

Farm size: Arable 30ha, Temporary grazing 68ha
Permanent grazing 219ha, Rough grazing 140ha
Farmed under a mixture of secure tenure, SLDT, seasonal and cropping agreements.

Enterprises: 100 suckler cows, offspring sold as yearling stores
1050 ewes, offspring sold as a combination of store and finished
60 purchased bulling heifers, which are sold with calf at foot

Altitude: rising from 304m to 550m

Facilitators:
Alister Laing, 07979 245 909, alister.laing@sac.co.uk
David Ross, 07765 220 234, david.ross@sac.co.uk

Lost comprises four units spread around Strathdon with a 20 minute round trip. The cropping is mainly grassland, with 24ha of spring barley and 6ha of turnips grown. Livestock comprises 100 Simmental X suckler cows producing store cattle. A further 60 bulling heifers are purchased to sell with calves at foot. Around 100 ewes produce prime and store lambs.

Main Monitor Farm topics covered over the last year:

- Grassland Management – looking at sward composition and grassland identification, designing reseed policy to ensure that any field to be reseeded will be soil tested prior to ploughing. If phosphate levels are low apply extra water soluble phosphate.

- Cattle Breeding and Fertility Policy – looking at improving cow and bull fertility. This involved looking at the advantages of a compact calving. Going over the things that should be carried out for a bull MOT such as feet, gait, testicles etc. Going over the five key points linked to fertility, cow condition, bull fertility, avoiding difficult calving, heifer management and herd health.

- Open Day – looking at the livestock and assessing the issues with the forage crops that had to be re-sown. This is the challenge described below.

- Lost Sheep Policy – consider the following changes 1 Sell store lambs earlier. 2 Feed ewe lambs to get them up to weight. 3 Raddle the tups and switch colour after first cycle. 4 Let one batch of ewes lamb themselves and then use the best ewe lambs as replacements. 5 Look at nutrition and health along with tup MOT.

- Tax implications – Looking at the issues surrounding upland farms in the current tax regime. The main areas covered were:

  Tax relief on new sheds and on shed repairs.

  o There is no tax relief available on the actual building of the shed, but integral features from then on have 100% tax relief. Any equipment inside the shed qualifies as plant and machinery. For shed repairs always try to take pictures to prove it is a repair and not a new shed, as repairs get 100% tax relief but new sheds have no tax relief. Capital expenditure – when best to buy new equipment and if the price is too high then would it be better to use hire purchase instead!

  o Wages and Profit and Loss Accounts RTI (real time information) has changed the way wages are now done. Originally the value of national insurance and tax paid by the employee was simply recorded annually and sent to the revenue based on the employee's P60. However, now this information is passed on monthly on every pay day throughout the year to get a clearer picture of what is happening.

  o The Future – always have a will!

- Livestock Costings – produce the costings for the unit from the last two years' accounts. These highlighted the fact that the suckler cows were losing money and the sheep were still profitable despite seeing a big drop in profit between the two years due to the price of lamb.

Taking up the challenge

The last year saw a very dry and warm March but unfortunately the weather turned cold and wet and saw a year that was very bad for crop growth. This resulted in poor growth of crops and in particular forage crops which play an important role on the farm. The challenge was what to do with the fields that are not growing very well.

The evidence

In late spring the Gordons had sown two fields, totalling 20 acres, with turnips. At the June 26th meeting, the Gordons had shown the community group a virtually bare field of what should have been a young turnip crop. Initially the turnip seedlings had thrived, but by the third week of June the crop (and weeds!) had disappeared.

Some of the community group had experienced similar problems and blamed a combination of slugs, leatherjackets and weather. The group had suggested giving the crop a chance to recover. It did not.

The actions

By early July they decided to re-sow the turnip fields with forage catch crops, but it was too wet for weeks to get onto the ground and they didn't get the crops sown until July 27th.

One of the fields had been sown with a kale/rape hybrid (variety – Pulsar), the other - a mixture of stubble turnips and kale/rape hybrid. Both crops received 213 kg/ha of 21.08.12 at sowing, and have thrived.

The outcome

With catch crops there is a definite growing period, usually about 16 weeks, after which there is no further growth. So in a normal weather year, it's worth aiming for a sowing date which ensures the crop is at its maximum feed value when utilisation is planned.

Forage brassicas have a long tap root, which helps to break up the soil pan, with root hairs growing from this tap root. The root hairs take in nutrients from the soil to feed the plant, and to do this efficiently, they need oxygen. If the root hairs are waterlogged, as many have been this year, they are starved of oxygen and nutrient intake does not happen, therefore the plants will not thrive.

Soil compaction also reduces the amount of oxygen in the soil around the root hairs, inhibiting plant growth.

Prior to the re-sow, the land had been power-harrowed, to reduce compaction. Nevertheless it was clear that plants in the compacted headlands as well as in wet hollows, had not thrived as well as others.

The Gordons are understandably relieved that what had been 20 acres of failed crop in late July, now promises excellent winter feed for their stock.

"I've been really impressed with the performance of the catch crops," said Charles Gordon. "Maybe next year, we'll reduce the turnip acreage and veer more towards forage rape and kale."

CAITHNESS & SUTHERLAND MONITOR FARM

Date of first meeting: February 2010

Name of Monitor Farm: Caithness and Sutherland

Farmer's name: Johnny MacKenzie

Farm name: Westfield Farm

Address: Westfield, Thurso, Caithness

Postcode: KW14 7QN

Ownership: Johnny MacKenzie

Farm size: Temporary grazing 132ha, Permanent grazing 60ha
Rough grazing 31ha, Environmental schemes 176.5ha
A further 410ha is rented on a seasonal basis.

Enterprises: 318 suckler cows, offspring sold as yearling stores
800 ewes, offspring sold as a combination of store and finished

Altitude: Up to 100m above sea level

Facilitators:
Willie Budge, 07834 243022, willie.budge@sac.co.uk
Derek Hanton, 07803 222363, Derek.hanton@sac.co.uk

Westfield comprises 230ha which is all down to grass or rough grazing. The main enterprise is 300 Saler x Simmental suckler cows producing store cattle. There are 800 North Country Cheviot commercial ewes producing prime and store lambs.

Main Monitor Farm topics covered over the year

- Bull MOTs

  The seven Salers and three Simmental bulls were tested. Each bull test was completed on average within 15 minutes.

  The "MOT" consists of:
  o Physical Examination
  o General examination and vaccination history
  o Body condition
  o Musculoskeletal system

  Service behaviour must also be monitored, with cow in standing oestrus, initial behaviour, ability to mount, intromission and ejaculation.

- Succession

  Provide members of the community group with a starting point for the process they require to go through. The three main points were:
  o Decide what you and the family want
  o Work out how to achieve it
  o Equip the successor(s)

- Johne's – PARABAN project

  Westfield continues to participate in the PARABAN project. The key messages from the PARABAN team were:
  o Be aware of your disease status
  o Develop a long term strategy (with vet and health scheme)
  o Make decisions on culling, frequency of testing, repeat testing

- CAP Reform

  The focus on the proposed changes post CAP Reform and how farmers could plan ahead.

Taking up the challenge

The challenge was to reduce the barren rate of cows and heifers.

The evidence

Westfield had an exceptionally poor cattle scan in 2010 which although improved in 2011 was still on the high side. The Monitor Farm Community Group felt this could be improved upon further.

The actions

Following the results of the 2011 cow scan it was decided action was required. The results are shown below:

Table 1 – Cow Scan Comparison

Cows	Barren 2011	Barren 2010
	6%	14%

Table 2 – Heifer Scan Comparison

Heifers	Barren 2011	Barren 2010
	27.5%	60%

Following the results being assessed, the Community Group decided with Johnny to complete bull MOTs. The 7 Salers and 3 Simmental bulls were tested. Each bull test was completed on average within 15 minutes. The "MOT" consists of:

- Physical Examination
- General examination and vaccination history
- Body condition
- Musculoskeletal system

Musculoskeletal examination	Genitalia
Feet	Scrotal circumference
Angle of pastern	30 to 34 cms. 12 to 24 months
Angle of hocks	Palpate testes
Straightness of limbs	Palpate penis
Gait	Examine internal genitalia
Spine and limb defects	

Service behaviour must also be monitored, with a cow in standing oestrus, initial behaviour, ability to mount, intromission and ejaculation should be assessed.

In summary the steps to be followed would be:

1. Physical Examination
2. General examination and vaccination history
3. Body condition
4. Musculoskeletal system
5. Continued bull management throughout bulling season

The outcome

The scrotal circumference of the Westfield Salers ranged from 37 to 42cm. Whilst the Westfield Simmentals ranged from 42 to 45cm.

Whilst no problems were found at the MOT, this gave peace of mind to the Monitor Farmer for the bulling season. By undertaking the MOT all bulls were known to be fit for service.

Table 3 – Combined Cow and Heifer Scan 2012

Number Scanned	Number Barren	% Barren
318	17	5

Table 4 – Cow Scan Comparison

Cows	Barren 2012	Barren 2011	Barren 2010
	4%	6%	14%

Table 5 – Heifer Scan Comparison

Heifers	Barren 2012	Barren 2011	Barren 2010
	9.8%	27.5%	60%

- The clear outcome has been the dramatic reduction in barren rates since 2010.
- Heifer barren rates are still above average but Westfield now has a system in place which should see this drop in 2013.

Farmer quote "I feel the improved scan results have been a combination of the bull MOTs as recommended by the Community Group as well as better management of the cattle during the bulling season".

Facilitator quote "After a disastrous scan in 2010, Westfield has turned around the scanning figures with the help of the Community Group. The overall barren rate for cows and heifers combined in the 2012 scan was down to 5%".

CENTRAL DAIRY MONITOR FARM

Date of first meeting: March 2010

Name of Monitor Farm: Central Dairy

Farmer's name: Sandy Milne

Farm name: Carcary Farm, Brechin

Address: East Pitforthie, Brechin DD9 7PQ

Ownership: Family Owned

Farm size: 506Ha, split 247 Ha silage ground for dairy herd and the rest arable and potato lets

Enterprises: Dairy, Arable

Altitude: 30m above sea level

Facilitators:
Sophie Kinnear, 07717 500877, sophie.kinnear@dairyco.ahdb.org.uk

The dairy is run as a large-scale enterprise with a high input-high output system. Average milk yield was 9,712kgs sold, with a calving interval of 433 days. The herd is fed on a Total Mixed Ration (TMR) with no in parlour feeding. The herd is milked three times per day through a 32/32 herringbone; average milking time is three hours.

Main Monitor Farm topics covered in the year

- July – 2nd Milkbench+ feedback – this meeting looked at the financial and physical performance data of the Community Group through the use of Milkbench+ benchmarking from DairyCo. During the meeting group discussion and use of each farm's benchmarked figures, helped to highlight areas where everyone could improve and learn from each other.

- November – Fertility – The group discussed what the most important KPIs were for monitoring fertility levels. The general consensus was the 100-day pregnancy and 200-day non-pregnancy rates, were the most simple and effective management tools.

- December – Mastitis 3 Ian Ohnstad – Satellite meeting at Allan Alston's farm, focussing on how to reduce herd mastitis and SCC, especially in the fresh calved cows. Through looking at the whole system the group alongside Ian found that the cause of the mastitis issue was coming from the dry cow period and not as a result of the parlour routine. The meeting highlighted how important record keeping and use of records are in order to make the best informed decisions. Allan and Sandy have since built a strong working relationship with Ian, and aim to employ him on a shared consultancy-basis after the conclusion of the Monitor Farm project.

- February – Trip to London – The Community Group undertook a study tour round five farms in the London area in mid-February. The objective of the trip was to take the group to a similar farming area (dairy and arable systems) to see how other dairy farmers are working in order to pick up some tips and ideas, but most importantly, to see how well they are working as a group and to leave with a positive and inspirational view of dairying from Brechin to London, UK wide. This was certainly achieved! The group returned with lots of fresh ideas and all involved would like to thank the host farms visited for their time, openness and generosity.

- February – Final Monitor Farm meeting – Where next? The final meeting of the project focussed on the whole farm review in order to complete the project leaving the Milne family with a view of their whole business, their opportunities and areas for development. The meeting discussed three potential ideas for the future of East Pitforthie dairy, as a group, with technical input, future progress and moves for the Monitor Farm agreed. This drew to a close the Monitor Farm project by reviewing highlights and suggested future strategies for Carcary Farm as well as for members of the Community Group.
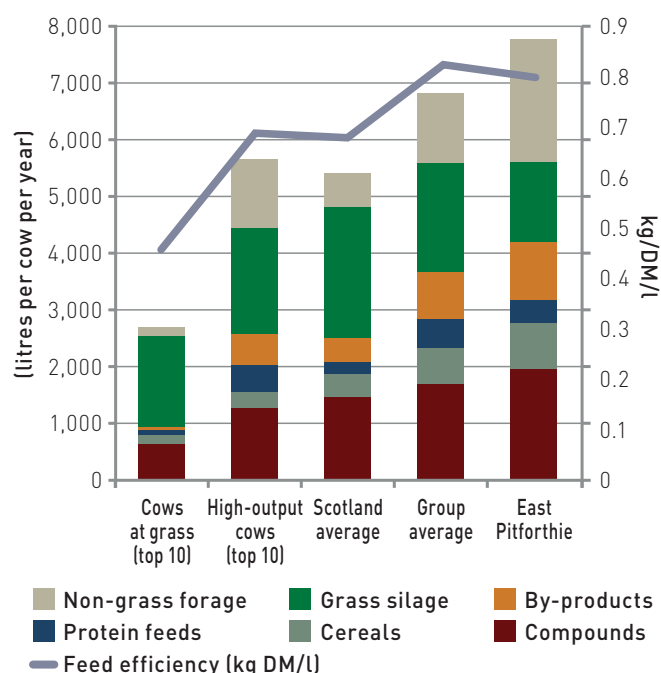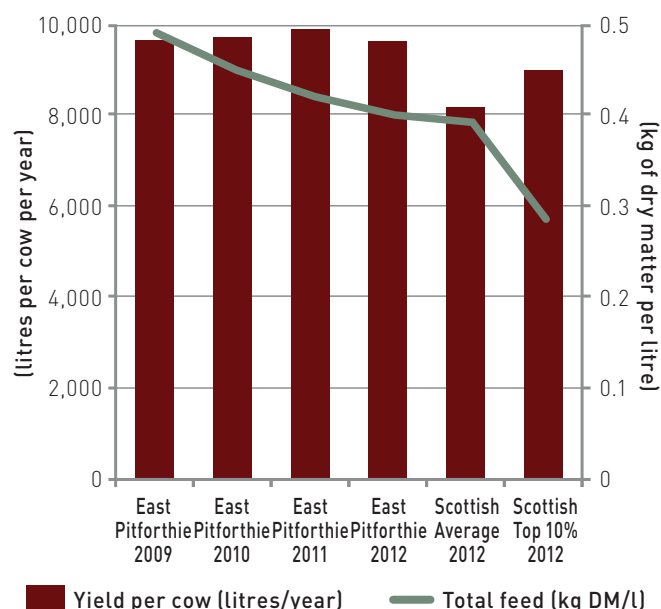
Taking up the challenge

The challenge for the farm was to improve feed efficiency and yield output, while maintaining and improving the health and fertility of the herd. The particular focus was to improve feed use from both home-grown and bought in feed; this challenge was tackled from varying angles.

The evidence

Feed was highlighted as the biggest cost across all dairies; with the Brechin Community Group having higher feed and forage costs at 36% of output, compared to the national average of 32% of output.

Yield per cow has increased in the first three years of the project. However, in 2012 yield has decreased on the back of unfavourable weather conditions. At the same time, the amount of feed and forage fed per cow has decreased continuously each year from 0.49 kg DM per litre in 2009 to 0.40 kg DM per litre in 2012, resulting in increased feed efficiency, an area that can still be improved on.

Yield per cow (litres/year) ▬▬ Total feed (kg DM/l)

Non-grass forage Grass silage By-products
Protein feeds Cereals Compounds
Feed efficiency (kg DM/l)

The actions

The Community Group went 'back to basics on feeding and cow signals', with Karen Lancaster and Donald Brown as the guest speakers for an informative and down to earth discussion. The group viewed a time lapse cubicle house video, from one of the Community Group member's farm which highlighted the frequent feeding and general socialising of the herd, and emphasised the importance of adequate feed space and the importance of the housed environment and presentation of feed are in order to maximise intakes and production. Following this an evening meeting was held with two independent nutritionists Donald Lawson and Adam Clay entitled, "Feeding ideas and inspiration." This meeting was particularly interesting and prompted Carcary Farm to review its dry cow feeding policy as outlined below.

The introduction of thrice daily milking appears to have been beneficial to late lactation cows resulting in increases in production. Cows subsequently fed on the high yielding diet, may have resulted in increased production levels. Late lactation cows were previously averaging approximately 15 litres per cow per day compared to 20 litres per day, on three times per day milking.

The outcomes

Sandy and his team decided to implement one forage ration for far-off and close-up dry cows; with the latter group receiving 3.5kg of 16% dairy blend sprinkled on the top of the ration on a twice daily-basis. This should ensure cows receive the required energy intakes, and help reduce the variability of the old system, that was previously highlighted in a metabolic blood profile. The old system saw the close-up dry cow diet being mixed in the feeder wagon. Due to the small quantity of ration needed to be mixed at any one time this allowed for a greater margin of error in the mix. New blood profiles will be taken to observe whether measureable improvements have occurred, but judging from subsequent fresh cow performance, at this stage (Feb 2013) the measures appear to be a success.

There was a concern that lower yielding cows may increase body condition score whilst being fed on the higher concentrate diet. Later lactation cows (previously low yielding cows) were body condition scored in April 2012. The average condition score was 3.12 for the group.

The aim, to condition score the group every two months proved problematic, owing to the low yielding animals being mixed with the main herd. A final whole-herd condition scoring was carried out in June 2012. The difference in condition was recorded as +0.25.

What next for Carcary Farm? The aim is to improve on current performance levels, including continuation of the DairyCo Healthy Feet and Mastitis Prevention programme. At this stage, Carcary Farm aims to achieve the best possible results, by utilising current herd numbers, prior to any consideration of future herd expansion. Any expansion plans are likely to focus on the bulk tank being filled to its 14,000 litre capacity.

In order to achieve this target, the herd will require an additional 100 milking cows and this could, potentially, be managed by employing one additional member of staff.

After three years of participation as a DairyCo Scottish Monitor Farm, the Milne family and Carcary Farm team, have all thoroughly enjoyed and valued the experience. Suffice to say, there were many areas in which the business performed well and equally, there were areas that needed improvement.

The Community Group, with its regular attendees at meetings, has been the linchpin of the project. As time progressed the Group went from being a slightly insular, perhaps shy group of farmers, to being a strong group, open to discussion and information exchange.

CLYDE MONITOR FARM

Date of first meeting: 15th November 2012

Name of Monitor Farm: Clyde

Farmer's name: Andrew Baillie

Address: Carstairs Mains Farm, Carstairs, Lanark, Lanarkshire ML11 8QP

Ownership: Owner Occupied

Farm size: 253 ha of which 190 ha is agricultural with 63 ha woodland. Of this area 65 ha are classed as temporary grass, 22 ha permanent grass and 103 ha were cropped (which in 2012 included spring barley, winter wheat, fodder beet and chicory). An additional 19 ha of neighbouring seasonal grazing is rented each year.

Enterprises: A closed herd of 80 Johne's Accredited suckler cows which are predominately Limousin and British Blue cross cows mated with Limousin bulls. 120 head of dairy bull calves finished each year as bull beef. 235 ewe closed flock of which 100 are pure Beltex, 50 pure Texel and 85 crossbred ewes all of which are joined to Beltex rams.

Altitude: 100-130m above sea level

Facilitators:
Grant Conchie, 01555 662562, grant.conchie@sac.co.uk
Raymond Crerar, 01292 525458, raymond.crerar@sac.co.uk

A spring calving suckler herd producing bulls which are sold finished at 12-14 months of age. Surplus heifer calves are sold store at 10-11 months. Dairy bred bulls are sourced as weaned calves from two nearby dairy farms and sold finished. Beltex and Texel cross ram lambs are sold as shearlings and surplus females and cross lambs are finished and sold privately to a local butcher.

Main Monitor Farm topics covered in the year

- Open Day – an introduction to the farm and its enterprises

- Identify direction and opportunities for the Monitor Farm – the strengths, weaknesses, opportunities and threats were examined across the enterprises on the farm to help the discussions on the future direction of the farm business and the topics for future meetings.

- Identify ventilation issues in cattle sheds and solutions, and the causes and prevention of pneumonia in cattle. This is the challenge highlighted below.

- Establish a reseeding policy for 2013 – Andrew is proposing to reseed 25 acres (10ha) of grassland in a field adjacent to the River Clyde. The field contains a number of trees and Andrew was of a view he would only get one chance to reseed and control the docks, which he knows will be a problem. The group discussed the potential cultural and chemical controls Andrew could adopt when reseeding.

- Review the fertiliser policy for the spring barley – the FYM produced on-farm allows for an application of around 10t/acre (25t/ha) of FYM to all stubble ground. Having established the nutrient status of the soils and taking account of the nutrients provided from the FYM there is scope to reduce fertiliser costs by stopping applying bagged P & K to spring barley.

- Review of herd fertility. Herd fertility was not at the level expected. This was exacerbated for the 2012 calving period, with a proven bull not working in 2011. The group was invited to provide their data for the 2012 calving, which provided some interesting comparisons and reinforced that everyone has their problems.

Taking up the challenge

Pneumonia in cattle was a key issue affecting cattle performance on both the Monitor Farm and Community Group members' farms. Charles Marwood of Clyde Vet Group discussed the causes and management factors which reduce pneumonia. The group then moved to the farm to discuss ventilation in the three main cattle sheds.

Key Messages

- Pneumonia is a multifactorial problem
- If you do not consider all of the risk factors and are only looking for a vaccine you will never get on top of pneumonia
- Shed ventilation must work on still days with no wind
- The stack effect will ventilate the building and keep rainwater out – do not be afraid to remove the ridge on the roof
- To reduce humidity keep slurry level in underground slats low and muck straw courts out monthly

The evidence

Pneumonia

Main Risk Factors for Pneumonia

- Poor Housing
- Stress – weaning, dehorning, castration, moving
- Biosecurity
- Diet/Nutrition
- BVD – suppressing the immune system
- Stocking density
- Weather
- Ventilation
- Concurrent Disease
- Mixing cattle of different ages

Primary Causes

The primary causes of pneumonia are grouped into three categories:

- Virus – RSV, PI3 and IBR
- Bacteria – Pasturella; Manheimia, Histophilus and Mycoplasma
- Parasites – Lungworm/Husk

All of the above, excluding IBR, are present on all farms.

IBR is present on around 50% of Scottish farms and it is important to keep it out if you don't have it. If a herd has IBR the adults are carriers from year to year and spread IBR to naïve young stock. If adult stock are vaccinated every year they are less likely to be carriers and will eventually leave the herd, helping to eradicate the disease.

Secondary Problems

Include:

- Bacterial pneumonia
- Reduced growth rates – resulting in reduced efficiency and leading to problems such as replacement heifers not reaching target bulling weights on time

Nutritional Stress

Inadequate diet and nutrition is a risk factor for pneumonia.

- Colostrum – quantity and quality are fundamental to the protection of a calf's health.
- Rumen Function – sudden changes to the diet can have a major impact on the rumen.
- Concentrates – should be good quality and used to meet the nutritional requirements of the stock, but are highly fermentable and can readily affect rumen function.
- Minerals/Trace Elements – levels should be considered. For example, cobalt deficiency reduces the animals' immunity.

Environment

The environment within the shed is an important consideration with pneumonia. This can be affected by humidity, draughts/temperature and air quality. The humidity in a shed can be influenced by wet floors, wet coats and condensation on roof sheets. In relation to wet floors, in a shed with underground slurry storage there is a significant source of moisture, so if possible the level of slurry should be kept low. Equally in a straw-bedded shed, if straw has been down for one month it will have trapped urine, etc. and will be starting to heat and create moisture, so it would be good practice to muck straw courts monthly, to minimise the source of moisture.

Ventilation

Correct ventilation of livestock sheds is important for a number of reasons:

- Removes moist vapour from stock
- Aids evaporation from dung, bedding and spilt water
- Minimises condensation, so protects the fabric of the building
- Maintains a fresh air supply
- Keeps down microorganisms and reduces the risk of pneumonia
- Keeps down dust
- Prevents wet coats

Ventilation must work on still, damp days – do not depend on wind to assist airflow. The stack effect will ventilate the shed as long as all of the relevant factors have been calculated and controlled.

The actions

Farm Visit

Smoke bombs were lit in each shed to assess the effectiveness of the ventilation and air flow in the sheds. If the smoke clears from the shed within two minutes the ventilation is acceptable. Unfortunately, on the day, the conditions were not ideal for smoke tests as there was a significant easterly wind. This impacted on the speed that the smoke exited the sheds.

Main Shed

Andrew confirmed that he does not have many pneumonia problems in this shed. The shed has an open ridge above the feed passage with Yorkshire boarding on the southern gable and western side. It is understood that the shed previously had a ridge cap, which was removed by the previous owner following a smoke bomb test.

At present, half of the shed is used for housing cattle and the other half is general storage. The Group's view was that this was a good airy shed. The smoke took 50 seconds to clear the shed, which is well within the desired two minutes.

There was discussion about the open ridge on the feed passage and some concern was raised that feed could get wet from rainfall. Andrew confirmed that during heavy rain in the summer (when the shed is empty) the feed passage gets wet, but it is dry during the winter. This confirms that the stack effect will keep the shed dry, so farmers should not be afraid to remove the ridge cap from a shed.

Bull Finishing Shed

This shed has very little air inlet and a capped ridge. Since moving into the farm Andrew has removed some side sheets to increase air inlet.

The smoke cleared from the building in 30 seconds, but little went via the ridge. The smoke was mainly blown through the shed by the prevailing wind, which is not a suitable form of ventilation.

There was general discussion on how to improve ventilation in the shed and the consensus was the ridge should be opened and side sheets on the eastern end of the shed should be removed and replaced with Yorkshire boarding.

Bull finishing shed – before ridge removed

Calf Shed

This is a very open shed, with the south side open, and the north side with ventair sheeting. The building also has an open ridge.

The smoke cleared again from the shed, but rather than moving to the ridge as expected, it billowed around the shed. The view was that there is actually too much air in the shed and it was too cold for the calves. Charles had concerns that the calves would get a chill and cattle need to be 200kg+ before they can handle thermal stress. If calves are cold their immune system will be suppressed.

There was discussion about the possibility of moving the calves to another shed, but there were other risk factors associated with this, such as sharing air space with older cattle. It was felt that something should be placed on the open southern side of the shed to reduce air inflow. Discussion on the type of product followed and the general view was that Yorkshire boarding would be the most cost effective and longest lasting option.

The outcome

Buildings

- By the third meeting on 13th February 2013, Andrew had removed the ridge from the main bull shed to increase the air outlet. This has significantly improved the air quality and light in the shed. The shed has been smoke bombed again and the air flow is much better.

Bull finishing shed – after ridge removed

- Secure Cover windbreaks have been attached to the side of the young calf shed, which has made a massive difference. This cost £1,000 and Andrew erected them himself.

- To cover the same area with permanent Yorkshire boarding was going to cost £1,200 in materials plus labour cost.

- If in the future the calf shed is extended by another span, the Secure Covers can be removed and re-erected on the outer side of the shed.

- Pneumonia – There had been no incidences of pneumonia since the last meeting and no antibiotic had been administered in the past three weeks.

DUMFRIES MONITOR FARM

Date of first meeting: 13th December 2012

Name of Monitor Farm: Dumfries (Beef Finishing)

Farmers' names: John and Amanda Paterson & Family

Farm name: Hartbush

Address: Hartbush, Amisfield, by Dumfries DG1 3LN

Ownership: Owned with some seasonal grazing lets

Farm size: 245 ha Owned; 52 ha seasonal grazing lets
137 ha grazing; 74 ha cut for silage, hay and haylage;
26 ha winter barley for own use and 52 ha of seasonal grazing lets

Enterprises:

Cattle 260 Simmental cross suckler cows
Charolais, Limousin and Simmental bulls used
Finishing 180 head (young bulls, steers and heifers) per year
Retaining 30 breeding heifer replacements
Remaining young stock sold store

Sheep 410 Half Bred ewes put to Suffolk tups
Some ewe lambs sold for breeding
The remainder finished

Altitude (m): From 50m-200m above sea level.

Nitrate Vulnerable Zone: Yes

Facilitators:
Matthew Currie, 01387 274 381, matthew.currie@smithsgore.co.uk
James Worthington, 01387 274 383, james.worthington@smithsgore.co.uk
Judith Hutchison, 01387 263 066, judith.hutchison@smithsgore.co.uk

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Hartbush is a mixed LFA farm, situated in an NVZ, with 260 sucklers of which 180 head are finished, 30 are retained for breeding and the remainder are sold as stores. It also has 410 ewes and sells both ewe lambs and finished lambs. Hartbush grows some cereals for the beef and sheep enterprises and the arable – grass rotation maintains high quality swards for both conservation and grazing.

Main Monitor Farm topics covered in the year

- Introductions to Hartbush, the Monitor Farmer team, the enterprises and how a Monitor Farm works.

- Priorities for selecting breeding replacement animals and how to utilise EBVs – members discussed the fact that producers will have different priorities depending on whether they are looking to produce prime or breeding animals and on which traits (daily liveweight gain, calving ease, milk, birthweight etc) are most important to their own herd situation. It was acknowledged that the trick is to identify your own priorities and to stick to them when selecting replacement animals. EBVs are 'another tool in the box' and the information provided by EBVs can be used alongside conventional assessment criteria when choosing stock. Using EBVs does take time and effort in going through all the figures in a sales catalogue to narrow down prospective animals.

Traditional visual and locomotion assessments are no less important in identifying which animals should or should not be purchased.

- Selecting and preparing cattle for slaughter – members discussed how important it is to understand what their customers are looking for in terms of weight range, age range, fat class and conformation grades. Some processors are also looking for certain breeds fed to specific diets to fulfill some contracts with retailers.

- Following through the Hartbush cattle from live to dead at Highland Meats abattoir in Saltcoats and the 'Hartbush Stock judging Challenge' (Judging: Liveweight; Deadweight; Grading; Average Lifetime Daily Carcase Gains and Values of old cows). These are highlighted in the following challenge.

Taking up the challenge

Given the involvement of Highland Meats and A K Stoddart in this Monitor Farm Project, early interest was shown by the Community Group in learning about what processors are looking for from producers and how farmers can improve their own practices at home in relation to what types of animals they produce and how best to present them for sale to processors.

The evidence

Processors and beef industry commentators indicated that the knowledge and understanding within the industry could be built upon to the benefit of both farmer and beef processor alike. This focussed on such areas as why certain types of carcases are preferred by the processor; how lifetime management of cattle impacts other members of the beef marketing chain; and how the eventual presentation to the slaughterhouse could be improved to the benefit of both farmer and beef processor. It was also felt that seeing and discussing what happens to cattle beyond the farm gate would have considerable benefits for all in the beef supply chain.

The actions

This was undertaken as a two part exercise. Firstly on farm [day 1] then a week later a visit to Highland Meats' abattoir [day 2] to see dressed carcases of some of the Hartbush cattle post slaughter.

A. Day 1 – On the farm – Jim Ford, of A K Stoddart, demonstrated the differences and importance of

- Conformation – relating where the different cuts of beef come from in a carcase and their values
- Fat class – explaining what fat cover is ideal and the problems encountered if animals are too fat or too lean
- Weight gain – explaining those periods of particularly low levels of nutrition will lead to layers of tough gristle in the meat which reduces the value of the meat. This will not disappear during periods of increased feeding in later life.

George Brown, of Highland Meats, commented on the impact of cattle with different levels of cleanliness; highlighted tagging and management issues from a processor's perspective. He went on to discuss how best to prevent common issues around these areas, as well as demonstrating to attendees exactly what is required when clipping cattle.

The "Hartbush Stock-judging Challenge"– Attending members were asked to judge pens of steers, heifers or old cows. But it was stock judging with a difference!

Members were asked to estimate

1. Killing out % of four continental heifers
2. Grades of four continental steers (conformation and fat class)
3. Average lifetime daily carcase gain (kg/day) for four continental steers
4. Liveweight of four continental heifers
5. Deadweight and value of four continental old cows

B. Day 2 – At the abattoir – Community Group members saw the resultant carcases from Hartbush cattle hanging up and could see the varying conformation and fat class grades for each class. They had the opportunity to discuss the differences between animals in each class and were able to recall how they related to the live "Stock judging Challenge" they had done the week before.

Groups then saw the kill line in action observing each stage of the process following animals from the lairage, through slaughter and carcase preparation for grading along with what happens to the "fifth quarter". The processors demonstrated how they go to considerable lengths to minimise waste, maximise sales values and to make each stage of the slaughter process as simple and efficient as possible.

After lunch Isla Roebuck and Highland Meats staff gave a presentation on Highland Meats' participation in the beef chain and their ambitions for the future growth of the business.

The outcome

A. Day 1 – On the farm – Community members heard first hand from Jim Ford and George Brown, what they had to say on selection, management and preparation of animals for slaughter. In addition they heard what other farmer members do on their own farms, sharing good practice and helping one another with particular challenges highlighted and encountered.

The top tips gathered on Day 1 were

- Ensure you understand what your customer/the processor wants

- Identify market/your customers' needs and then breed, buy, feed and select cattle appropriately

- Too little finish means you are losing potential value on the animal

- Too much finish means you have fed the animal too much for too long and it has cost you more than it needed to – you will also lose value on the animal through penalties on the payment grid for over fat carcases

- The importance of keeping animals as calm and quiet as possible, right up to the time they leave the farm. Not to cause stress by mixing them in new groups, moving them into a different shed, changing their feed rations or handling them unnecessarily for the last few days

- That stress causes a lack of energy in the muscles which then affects the way the meat matures. This leads to 'dark cutting meat' which is tough, of poor quality and is worth less to sell. It can take two or three days for the energy levels in an animal's muscles to raise back up to normal levels after the animal has been stressed

- How to ensure clipping is done safely and to the required standards – keeping animals quiet and calm throughout if at all possible

B. Day 2 – At the abattoir – Community members saw the Hartbush cattle hung up as carcases and discussed their differences and could evaluate how they graded in comparison to their stock-judging estimates of the previous week. All remarked how they found it very interesting to see, discuss and learn at first hand from the two day exercise "back to back" and especially as they were following the same cattle right through.

All present were struck by how quiet the cattle were right up to slaughter – demonstrating the importance processors place on avoiding high stress levels pre slaughter which are a major cause of tough, poor quality meat.

Each stage of the slaughter process was seen to be very well thought out, in order to make it as efficient and straightforward as possible. Each operator on the line completed his tasks within a defined time as the carcases moved along from one stage to the next.

During the discussions after lunch, it was explained that cattle processors are almost the opposite of an assembly line. As they effectively dis-assemble carcases into their component parts, by grading and sorting all the products and then finding the appropriate markets to sell these components into.

Top tips from the abattoir were

- Keep stress to a minimum to avoid poor quality meat being produced

- Producing a carcase outside stated weight and grades, costs extra to trim off excess fat etc and can lead to more waste to be disposed of (which is costly)

- E and U graded cattle produce more high value meat

- The kill line is a very slick process and it is important to make this as efficient as possible by supplying processors with cattle within their specification range.

C. The Hartbush Stock-judging Challenge results

Animal ID	Animal ID	Animal ID	Animal ID	Animal ID
Class Number & Class Category	A	B	X	Y
1 – Killing Out % of 4 Heifers	62.6	52.5	54.5	56.2
2 – Grades (Conformation & Fat Class) of 4 Steers	-U 4L	R 4L	O+ 4L	R 4L
3 – Average Daily Carcase Gain (Kg/day) of 4 steers	0.65	0.66	0.68	0.72
4 – Liveweight (Kgs) of 4 Heifers	640	712	702	746
5a – Deadweight (Kgs) of 4 Old Cows	415	399	433	433
5b – Value (£) of 4 Old Cows	1224	1157	1279	1301

Observations

- Very few members identified that there would be a 10% points difference in killing out % in Class 1 from highest to lowest.

- Although the animals in Class 3 were selected to be of similar age. Members found this class the most difficult to get right.

- Most members underestimated the liveweight of the heifers (by an average of 15% or 105 Kgs)

- Most members underestimated the deadweight of the cows (by an average of 17% or 71 Kgs)

- Most members underestimated the value of the old cows (by an average of 25% or £310)

Comments

1. It is really important to estimate accurately the live and deadweights of animals so that the eventual value to the farmer can be judged realistically. Weighing cattle at specific times would be ideal but (in situations where scales are not available) measuring an animal's girth has also been found to be a reasonably good way of predicting liveweight.

2. Carcase weight gain/day is a key component of production in a profitable beef enterprise. Perhaps we need to think differently about what and how we measure on farm.

3. It can be well worth feeding old cows for slaughter. However, identifying which animals can put on weight and value relatively quickly and efficiently is important.

FORTH MONITOR FARM

Date of first meeting: November 2012

Name of Monitor Farm: Forth

Farmer's name: Duncan McEwen

Farm name: Arnprior

Address: Arnprior, Kippen, Stirling

Ownership: Tenanted

Farm size: 330 ha in total

150 ha temporary grass, 30 ha permanent grass,
60 ha rough grazing, 90 ha arable

Enterprises: 75 suckler cows, 500 breeding ewes,
90 ha of arable ground growing spring barley,
winter wheat, spring beans and spring oats

Altitude: 8m above sea level on the carse ground
up to 180m at the top of the farm

Facilitators:
Colin MacPhail, 01786 450 964, colin.macphail@sac.co.uk
Stephen Whiteford, 01786 450 964, stephen.whiteford@sac.co.uk

Arnprior is a mixed livestock and arable farm situated to the west of Stirling. There are 75, mainly Simmental and Limousin cross suckler cows which go to the Limousin and Simmental bulls respectively with all progeny normally finished on farm on a home grown ration. The 500 Scotch Mule ewes go to the Texel tup to produce finished lambs which are sold through the Caledonian Mart in Stirling. A mix of spring and cereal crops are grown with much of the spring barley being sold for malting.

Main Monitor Farm topics covered in the year

- Initial Farm Tour and Review – the Community Group was formed and invited to assess the opportunities for development at Arnprior Farm and identify issues to address that are in common to their own business.

- Liver fluke in cattle and sheep – poor performance of finishing cattle at grass, losses of sheep and poor finishing performance of lambs have resulted from livestock infected with liver fluke at Arnprior this year. SRUC vet David Gibson and Philip Skuce from Moredun were in attendance at the second Forth MF meeting to demonstrate the lifecycle of liver fluke and the effects it has on livestock. They also covered management strategies to treat animals and to minimise the impact where liver fluke is present.

- Cattle finishing strategy – the decision was taken to sell a batch of under-performing cattle in the store ring during January 2013. The Community Group took part in a costing exercise to compare the result of selling store against finishing to assess whether or not the decision to sell forward was correct.

- Soil compaction and drainage day – a meeting was held at the beginning of March to look at drainage systems and soil management strategy to alleviate the effects of compaction. The Community Group went on a farm walk to look at the drainage systems that are in place at Arnprior and the compaction issues that exist. Seamus Donnelly, a soil specialist from SAC Consulting's Stranraer office, demonstrated various drainage solutions to solve any existing problems.

The respective solutions varied in terms of:

- drain depth
- volume of gravel
- spacing, diameter and layout of drains

The solution given would typically depend on the scale of the problem, the layout of the field and the type of soil present.

Taking up the challenge

With the decision taken to sell an under-performing batch of 43 cattle as stores, the group wanted to quantify whether or not this was the right decision. They did so by comparing the outcome with the result of a costing that reflected the output and additional costs associated with taking the batch through to finishing.

The evidence

Duncan regularly weighs his cattle from birth right through to finishing and has clear targets to achieve in terms of daily liveweight gain. He aims to achieve an average of 1.2kg/day over the lifetime of the animal. He has arrived at this figure as a result of performance monitoring carried out over several years and as a result he has identified it as an achievable figure that should provide an acceptable level of profitability for the cattle enterprise.

A home-grown ration is formulated to achieve the targeted DLWG. Table 1 below sets out the performance of the batch of cattle in question from birth right through to the time of sale:

Table 1

Date	Average Weight (kg)	DLWG (kg)
June 2011 (Birth)	52.78	0.99
7th June 2012 (Turnout)	358.30	0.52
5th August 2012 (Housing)	368.00	0.57
2nd November 2012	444.00	0.84
December 2012	484.50	0.90
Jan 2013 (Sale)	494.00 (488 days old)	0.90

The table shows that this batch of cattle were on average 0.3kg/head/day below Duncan's target and this influenced his decision to cut his losses and sell in the store ring while prices were high rather than buy in expensive feed and take them through to finishing weight.

With the batch of 43 cattle already sold, the group were keen to understand the process that had led Duncan to making the decision to sell store. They then wanted to look at the performance implications to the overall business and use the findings to help make an informed decision going forward as to the cattle rearing policy adopted by the business.

The actions

A group exercise was carried out using actual performance data for the batch of cattle to the point of sale. This was then taken forward to represent the output and additional costs associated with finishing the batch of cattle over the following two months. The result of this comparison is shown in the following tables:

Results of Selling Store in January 2013

Table 2 below is a simple costing to provide a gross margin (before forage costs) for the batch of cattle. Vet and medicine costs have been removed as there would have been no additional cost in this area had he kept the cattle on to finishing weight.

Table 2

Output	£/Head
Sales Average of 494kg @ £2.09/kg	1,030
Less Variable Costs	
Feed	159
Commission & Levies	40
Gross Margin	831

Comparative Costing Against Finishing the Batch

Assumptions:

Additional 70 days feeding to mid April.

Cost of feed was calculated at £1.79/head/day (silage not included) and this cost was multiplied by the 70 days and added to the previous feed cost figure.

It is assumed that performance would not improve so DLWG was continued at 0.9kg/day over the 70 days.

Finished weight has been converted to a deadweight basis and the Scottish deadweight average price for mid January has been used.

Table 3

Output	£/Head
Sales Average of 306kg @ £3.78/kg	1,157
Less Variable Costs	
Feed	284
Commission & Levies	51
Gross Margin	822

The simple costing in Table 3 shows that Duncan was £9/head better off by selling his cattle as stores and in this case it would appear that he made the right decision if all the assumptions were to turn out to be accurate.

The outcome

The exercise allowed the Community Group to understand the process which led to Duncan making the business decision to sell the cattle as stores. Few argued against the decision that was made in light of the challenges that were faced with a very short grazing period of just six weeks during the summer of 2012.

The discussion soon focussed on the fact that there remains an opportunity to finish cattle at Arnprior. Even if cattle are not turned out at all in the event of similar weather patterns prevailing, performance should be maintained at 1.2kg/day to ensure cattle are finished within a normal time frame. Bearing in mind that the ration was designed to achieve performance of 1.2kg/day, the group looked at one further costing that showed the benefit of finishing the batch of cattle under circumstances that allowed the targeted DLWG to be achieved only for the extra 70 days through to finishing. Table 4 shows the result of this:

Assumptions:

Feed costs are carried forward on the same basis as previously for an extra 70 days.

Liveweight gain is increased to 1.2kg/day for those 70 days.

Table 4

Output	£/Head
Sales Average of 318kg @ £3.78/kg	1,202
Less Variable Costs	
Feed	284
Commission & Levies	53
Gross Margin	865

If 1.2kg/day was achieved only for the subsequent 70 days then an improvement of £34/head could have resulted which equates to £1,462 across this batch of 43 cattle sold in January. This provides an indication of the potential if 1.2kg can be achieved for the lifetime of the animal.

As a result of these findings, it was generally agreed that the strength of Arnprior farm, with its ability to produce high quality home-grown livestock feed cost effectively, lends itself to finishing cattle. Furthermore, the group identified the fact that in the context of the overall business, it was best to maximise gross output wherever possible in order to carry the fixed costs of the business. With these points in mind it was concluded that it would be best to continue with a cattle finishing enterprise at Arnprior wherever possible.

KINTYRE MONITOR FARM

Date of first meeting: March 2011

Name of Monitor Farm: Argyll (Kintyre)

Farmer's name: Duncan Macalister

Farm name: Glenbarr Farms

Address: Glenacardoch, Glenbarr, Tarbert, Argyll

Ownership: Wholly owned

Farm size: 716ha, barley 40ha, fodder rape 5 – 10ha, rotational grassland 120ha, permanent grassland 83ha, hill and rough grazing 210ha, commercial woodland 253ha

Enterprises: 145 Angus cross suckler cows – progeny all fattened 600 cross ewes – all lambs fattened

Altitude: Sea level to 100m above sea level

Facilitators:
Linda McLean, 07725 994521, kilmahofarm@btconnect.com
Alan Boulton, 07795 472442, alan@huntawayconsulting.co.uk

The Glenbarr Farms business is an amalgamation of three farms on the Kintyre coast focussing on the production of Aberdeen Angus and Hereford cross beef and finished lambs. The cattle are outwintered on a silage based diet and the farm is largely self-sufficient in forage and barley for finishing.

Main Monitor Farm topics covered in the year

- Sheep management. An analysis of the financial aspects of the two sheep systems on the farm and the formulation of a sheep health plan.

- Pasture rejuvenation as an alternative to some of the currently expensive ploughing. This had been proposed as a cost effective solution to some soil structure problems identified by the group with visiting specialist James Bretherton. Discussions and demonstrations of two types of over seeding techniques.

- Cattle management. A look at fertility issues and replacement policies aiming to reduce the age of the herd, tighten the calving pattern and increase the number of calves reared.

- Succession planning and topical tax issues. Encouraging early advice and provision for the complex issues of capital investment and passing on the farm.

- Cow and finishing stock diets. Improving cow condition to tighten the calving pattern and maximising growth in the fattening stock. Balancing the ambition to achieve maximum daily liveweight gain with the cost of rations and the timing of the finishing period to achieve optimum profit.

Taking up the challenge

The farm traditionally ran two sheep enterprises; Blackface ewes crossed to a Bluefaced Leicester and the resultant Mules crossed to Suffolk and Cheviot tups. The Blackies were easy to look after but had low output and the Mules gave a higher output but were very high maintenance. The flocks lambed early and late across a protracted period and Duncan wanted to rationalise the sheep enterprise into one operation, reducing the time and input costs without sacrificing productivity.

The evidence

The finances of both flocks were analysed to highlight the strengths and weaknesses in each operation and the opportunities for improvement in a new combined operation.

	Blackface flock (late lambing)	Cross flock (early lambing)
Lambing %	122%	154%
Lamb sales £ per ewe	£72.29	£98.40
Wool	£2.24	£2.24
Cull ewes	£3.38	£7.25
Net output per ewe	£77.92	£107.89
Total feeds and forage	0	£12.22
Bedding	0	£5.86
Vet	£6.36	£6.36
Other costs	£21.23	£21.23
Lamb finishing costs	£25.77	£3.65
Gross margin	£24.26	£58.17

- When compared with national flocks it was obvious that there was scope to increase the output.
- The high cost of finishing the later lambs inside was a significant drawback.
- The high costs of feeding and bedding the early lambing flock reduced the profit.

The aim therefore of a new combined operation was to maximise production whilst eliminating or minimising some of the high costs.

The actions

A meeting was dedicated to studying the financial analysis and reaching a consensus on how to change the sheep management. Prior to the meeting some blood tests were commissioned to see if there were any underlying health issues which might be affecting productivity. Whilst the tests showed the mineral status of the ewes to be fine, the ewes specifically tested for toxoplasmosis gave a positive result showing that the flock had a significant exposure to the disease.

With the help of local vet Catriona Wilson a health plan for the flock was devised which now includes vaccination of the gimmers for toxoplasmosis.

The group agreed with Duncan that moving the whole flock to a later lambing date could both remove the need for winter feeding and indoor lambing. The use of Lleyn tups to breed the cross ewes was seen as a way of reducing the high maintenance requirements of the Mules and removing the need for bought-in replacements.

The rape used to finish the lambs will have an inclusion of Italian ryegrass to increase its nutritional value and improve the ground cover in wet weather.

One of the arable fields in the grassland rotation has been sown with a red clover mix to increase the potential to finish lambs on grass.

The outcomes

- Duncan has reduced the flock by 80 ewes to allow the flock to run as one more efficiently.
- Virtually no feed has been used to winter the ewes saving approximately £3,700.
- No bedding has been used by lambing ewes saving approximately £1,500.
- Labour used to feed ewes has been re-directed.
- Scanning results for 2013 show the ewes to be in lamb at 185%. This means that the overall lambing percentage should rise by around 20% with significant cost reduction.
- Improved flock health may have resulted in the number of barren ewes being reduced to less than 2%.

MORAY & NAIRN MONITOR FARM

Date of first meeting: June 2010

Name of Monitor Farm: Moray and Nairn

Farmers' names: Robbie Newlands, farming in partnership with father Robbie and wife Kirsty.

Farm name: Cluny

Address: Cluny, Rafford, Forres, Morayshire IV36 2SJ

Ownership: Tenant

Farm size: 428 ha – arable 117 ha, difficult arable – mainly reseed only 71 ha, permanent grass 60 ha, rough grazing 115 ha, woodland/ whins 65 ha

Altitude: 50m to 220m above sea level

Enterprises: 150 beef cows, finish all calves, 650 ewes, all lambs finished, 150 acres feed barley, 26 acres swedes, 25 acres stubble turnips.

Facilitator:
Colin Anderson, 07500 012883, colinanderson2@sky.com
Peter Cook, 07774 160246, cooknewton@btopenworld.com

An upland LFA beef and sheep breeding unit finishing both entire male calves and heifers on an intensive barley ration. Lambs finished off grass, stubble turnips and pellets. All crops are consumed on farm with the cows wintered outside on swedes. Belgian Blue x Holstein Friesian cows put to Charolais bulls. Mule ewes are put to Suffolk, Texel and Hybrid tups.

Main Monitor Farm topics covered in the year

- Grassland Management – visual assessment of swards, discussion on their management, establishment techniques, varieties and use of clover. Also feedback on rotational grazing trials at the South West Scotland Grass Focus farm.

- Processors and the requirements of the beef market – judging of finished bulls on-farm followed by a visit to ABP Perth to view the slaughtered bulls and discuss market requirements. This was followed by a visit to Incheoch, Alyth courtesy of Messrs McGowan to study a very different cow type and system to that adopted on the Moray and Nairn Monitor Farm.

- July Open Evening – a chance for a wider audience to get the key messages coming out of the Monitor Farm. Visitors had a short farm tour and visits to five "stations" to cover Health Strategy, Improvements to the Sheep, the Cow System, Intensive Finishing and Recording Performance.

- Results of the protein feeding trials and review of heifer finishing given high feed grain prices – as part of the ongoing work on making the best margin from intensive finishing, a group of heifers were fed a protein rich diet to grow their frames before fast finishing. Also an earlier trial on soya addition to the barley creep was followed through to final finishing weights, to see if extra soya when young had a long term effect. The trials showed no significant difference in final weights and days to finishing. Revisiting the heifer costing (continue to finish intensively or switch to selling store?) showed the higher grain price eroding the benefit from finishing.

- Focus on Cow Fertility – the history of cows scanned empty in 2011 and 2012 was analysed and the actions for improving scanning and birth rates discussed.

- Focus on the Sheep Enterprise – changes made over the first two years were revisited, especially given the difficulty of finishing lambs off grass in 2012. The potential benefits of a new general purpose shed were discussed. Lamb grading and market outlook were incorporated into one meeting.

The Challenge

Cow fertility is a concern for all the cattle breeders in the group. Shouldn't it be possible to get a calf from every cow and heifer put to the bull?

The evidence

Robbie has a stubborn 10% of the cows and heifers run with the bull scanning empty (see Table 1). However, care should be taken in the interpretation of this figure as a number of the cows scanned empty would have been earmarked for culling, but not actually removed from the bulling herd until their calf is weaned. True barren rate may range from 5% to 8%. QMS national data and true calving figures from a number of QMS Business Improvement Groups (see Table 2) suggest calving rates of around 87% are typical.

Table 1. Scanning and Assistance Rates

	2011 Calving	2012 Calving
Scanned in calf	91%	89%
Number of assisted calvings at time of annual review Of which	24 (13%)	23 (13%)
Pulled easy	11	11
Pulled difficult	6	6
Caesarian	7	6

Table 2. Selected Calving Results from QMS Business Improvement Groups
Based on calves weaned per cow and heifer put to the bull. All 2010.

	Group 1	Group 2	Group 3	Group 4	QMS LFA Herds Average
Scanning/ PD rate (cows and heifers)	92 %	92%	96%	91%	
Overall calving %	79 %	89%	94%	87%	87%
Best calving rate	94%	96%	103%	94%	94% (top third)

Group discussion identified a number of features of the Newlands' system which could predispose to lower conception rates:

- Holstein influence in the cross cows may reduce fertility;

- Outwintering works well on this farm, but when combined with a type of cow which does not carry a lot of condition, maybe some of the cows have too low a condition score for conception in a bad year;

- The need to buy in heifers from a number of sources makes it difficult to have them in uniform condition, weight and age at bulling. It also raises the risk of buying in disease;

- Fluke has been an increasing problem and a major discussion topic.

The actions

Action 1: In both 2011 and 2012 Robbie listed the cows which scanned empty and did a simple description of some of the factors which could have resulted in poor conception.

Action 2: The group reviewed the 5 principles for improved herd fertility in the QMS publication available from the QMS website.

Action 3: Calved heifers and thin cows have been grouped separate from the rest of the herd to get a higher level of feeding and to avoid bullying

Action 4: The whole herd was screened for major diseases at the start of the programme, including Johne's and BVD.

The outcome

Some cows show no apparent reason in their history to suggest why they have not held to the bull. However, the listing in Table 3 suggests that the key factors in poor conception are:

- Difficult calving, especially caesarian – damage/stress not repaired by bulling time;

- Late calving – not enough time to recover condition pre-bulling;

- Any uterine health issue or unexplained calf loss;

- Sheer age – the older the cow the more chance of not holding to the bull. Is this a condition effect?

Separately grouping the second calvers has worked well – this group are not showing up as having particular conception problems. Health screening identified a BVD PI in the first year of the programme and prevented a major problem. Several Johne's reactors were also culled. Fluke have been implicated in poor conception rates on other farms and may have been an underlying factor on this farm. The cows used to be treated once per year for adult fluke in the spring, but the group felt that a further treatment with a flukicide in the autumn which kills immature as well as adult stages would "clean out" the cows and allow them to winter in better condition.

The move to scanning from PD has allowed empties to be removed for sale or finishing much sooner, eliminating some of the cost of barren cows and heifers.

The complexity of the fertility problem was shown up in autumn 2012 when the heifers had a particularly poor scanning, despite all the heifers being vet checked. Robbie is considering the purchase of a Simmental bull to breed his own replacements. Good quality dairy cross heifers are getting more difficult to source, and he feels he needs to get more control of the herd genetics, heifer management and health risks.

> **"This has been an interesting exercise and there's clearly no simple answer to improving fertility. What I actually want is the most cost effective way of breeding 150 finishing calves per year". (Robbie Newlands)**

"**This is a very complex problem. However, even a simple listing of the empty cows and their history helps suggest the areas to work on. As far as changing the system is concerned there is a trade off. Buying in dairy cross replacements has allowed the farm to operate a simple system – closing the herd may reduce risk and improve fertility, but it will add some costs and complexity". (Peter Cook, Facilitator)**

Table 3. Possible Reasons for Empty Cows 2011 and 2012

Cow no.	Calving score 1 = easy	Date calved last	Age (months)	Possible reason for not in calf
F17	1	31 March	149	Age?
G16	1	14 May	135	?
G19	1	10 May	136	?
H17	4	4 April	122	Tight calving
J16	1	21 June	111	Late calved
J19	5	21 April	109	Serious calving
K5	1	6 May	102	Own calf born dead?
L21	1	13 May	95	?
N18	1	5 May	67	Prolapse vagina pre/post calving
N32	1	18 March	61	?
P46	Caesarian	30 March	50	Caesarian breach
R1	1	17 March	37	??
R15	1	12 April	37	??
R2	1	11 March	37	??

Cow no.	Intended farrow season	Date of birth	Possible reason for not in calf
S29		27/05/2009	None
S21		20/06/2009	Breach birth, born dead, vet pulled
S11		27/05/2009	Late calved 10/06/12
R21		18/09/2008	Calved twins
R18		31/08/2008	None, but caesarian previous calving
R17		23/08/2008	Last cow to calf: 21/06/12
P6		13/03/2007	None
P5		06/02/2007	None
P48	Caesared twice	16/07/2008	Caesarian
P41		12/04/2007	None
P34		04/09/2007	Calf pulled "4" born dead
K19		08/09/2003	None (age?)
K1		26/09/2003	Calved twins
J6	Bad attitude	05/11/2002	Late calved: 14/06/12
J5	Bad feet	04/05/2002	None slight pull "3"
J1		26/08/2002	Breach "2"
H9		04/05/2001	None (age?)
H15	Old 3 tits	08/05/2001	Caesar, 3rd last to calf 17/06/12
H12	Old 3 tits	05/09/2001	Late calved: 04/06/12 plus pulled "3"
G5	Old	11/04/2000	Caesar
G22	Old	24/09/2000	Serious pull "5"
G2	Old	01/03/2000	None, but older cow

MULL MONITOR FARM

Date of first meeting: March 2011
Name of Monitor Farm: Mull
Farmer's name: Iain MacKay
Farm name: Torloisk Farm
Address: Torloisk, Isle of Mull, Argyll
Ownership: Tenanted
Farm size: 2900 ha in total – 2800 hill, plus 100 ha inbye/low hill
An additional 200 ha rented seasonally.
Altitude: Sea level to 391m above sea level
Enterprises: 50 Highland cows, 850 hill ewes
Facilitator:
Niall Campbell, 01631 563 093, niall.campbell@sac.co.uk
Donald MacKinnon, 01631 563 093, donald.mackinnon@sac.co.uk

Torloisk is an island hill farm situated on the west coast, with 50 Highland cows served by Highland and Simmental bulls. The progeny are mostly sold store, with some Highlanders going for breeding. The 850 ewes are Blackface, Cheviot cross BF and 50 pure Cheviot. All the lambs are sold as stores. Main labour is the Monitor Farmer Iain MacKay, who uses casual labour at peak times.

Main Monitor Farm topics covered in the year

- Sheep and Cattle EBVs – EBV workshop held, high genetic merit Texel tup purchased.
- Grassland Management – on-going reseeding, oversowing and forage crop programme proving successful.
- Sheep flock – in particular expanding production on the "low hill" and tweaking the sheep policy which was initially instigated in year one of the project.
- Suckler cows – evaluation of the profitability of this enterprise, cattle wintering option examined and calving period has been tightened.
- Successful, but very wet, Open Day held in September 2012 with around 70 attending.

Taking up the challenge

To add value to hill lambs, the farm would benefit from a system where it can finish lambs or graze lambs longer to ride out a slump in market price.

The evidence

Due to very limited inbye land, farmers and crofters on Mull usually have little flexibility with lamb marketing. Lambs need to be weaned off their mothers and moved off the farm to allow time for the ewes to gain condition for tupping. There is just not enough good quality land to both finish lambs and graze ewes. Iain is also involved in the Argyll Hill Lamb marketing project which pays a set price per kg deadweight for Argyll Blackface lambs. Target for these lambs is a liveweight of 38kg.

The actions

A six acre field was sown in June 2012 with a mix forage rape (Stygo) and stubble turnips (Samson and Delilah).

Blackface lambs (both male and female) were weighed going on and coming off the crop. Lean ewes were also put onto the crop, but not weighed. The table below sets out the dates when the animals were put on and off the crop together with the average weight gains:

The outcome

In conclusion, the establishment of the forage crop has been successful and will be repeated in future years. For such a small area it adds an extra dimension to the farm and improves the flexibility for the marketing of store lambs.

If lamb prices had been excellent and Iain had decided to sell more lambs store in the early autumn, it is still felt that the field would have been fully utilised by other stock on the farm. So there would always be a benefit from sowing this crop. Further advantages include the breakcrop nature of the forage crop. This ground is now in excellent condition for reseeding.

Type & Number of Stock	Date On	Average weight at start	Date Off	Average weight change	No Grazing days	Average Gain/day
60 BF Lambs	28/09	28 kg	11/12	8.7kg	74	118g/day
75 BF Lambs	11/12	25 kg	15/01	3kg	35	86g/day
20 Cast Ewes	28/10	Not weighed	15/01	N/A	79	N/A

Comments:

- An average of nearly 26 ewes and lambs per acre utilised the crop.

- Total overall average weight gain for the lambs is in the region of 102g/day.

  o This is perhaps lower than anticipated. However autumn and early winter conditions had been particularly wet, with the crop not quite as bulky as last year.

- 14 of the initial 60 lambs were ready to slaughter when they came off the rape, the remainder were too light. Iain felt if it was a drier year then more lambs would have been finished before Christmas. These lambs all went into the shed for final finishing before they were ready to go through the Argyll Hill Lamb project.

- The 75 lambs which went on to the crop in December grew more slowly.

  o In general, lambs lighter than 25kg are unable to utilise the forage crop as efficiently as lambs over 25kg as the rumen of these smaller lambs is not quite mature enough. This would explain the lower weight gain, as the 75 lambs weighed an average of 25kg and some would therefore be smaller. However, Iain was still pleased with their progress when they came off.

- The ewes came off the forage crop in much better condition than they went on.

NORTH EAST ARABLE MONITOR FARM

First meeting: 17th May 2011
Name of Monitor Farm: North East Arable
Farmer's name: Andrew Booth
Farm name: Savock Farm
Address: Foveran, By Newburgh, Aberdeenshire
Ownership: Mixture of owned and tenanted. Family partnership
Farm size: 345ha in total of which 282ha is owned
Enterprises: 276ha of cereals (OSR, WB, Wh, SB & Oats).
Finish 250-300 cattle per year, all AA crosses.
Run a successful farm shop, butchery and coffee shop – 'The Store'
– which employs over 20 staff
Altitude: 90m above sea level
Facilitators:
Jim Booth, 01651 843607, jim.booth@saos.coop
Peter Cook, 07774 160246, cooknewton@btopenworld.com

Arable farming in the north-east of Scotland is a challenge as it is a relatively late region. The Booth's farm is a typical family farm with the added challenge of having heavy soils which are poorly structured. The family also admitted they have concentrated their efforts in establishing the farm shop in the past, and have neglected the farm business to some extent – thus their motivation to become the Arable Monitor Farm. The farm operates a number of rotations depending on the land and situation. There are four blocks of land up to 10 miles apart. They carry out all the work themselves and contract combine some neighbours' crops. There is one full-time man on the farm.

Main Monitor Farm topics covered over the year

Interestingly the importance of the basics have been highlighted; soil structure, crop mix, rotation, organic matter, drainage, managing difficult soils and nutrients. The adoption of precision farming techniques has helped provide information enabling growers to refocus on the basics. The project completed its second year in 2012 with meetings covering a range of topics including:

- Visit to Knockothie Farms, Ellon. One of the largest arable farming businesses in the north-east, extending to 950ha (2,348 ac). The aim was to visit a progressive arable business on similar land, taking learning back to the Booths.

- Soils, root development and crop nutrition – this was a practical in-field session looking at the impact of soil structure, soil nutrients, benefits of organic matter, cultivation techniques and their impact, and how best to manage those poor areas in fields.

- Review lessons from 2012 season – gathering the group's experience from the 2012 harvest. Key lessons were: yields down 1-2.5t /ha across the board, quality variable, spraying progs really challenged, problem of FFA in OSR, forward selling too much, benefit of chopping straw to clear fields, and take your chance when it comes!

- Precision farming – farmers are at different stages of adopting precision farming (field and soil mapping, combine yield monitors, autosteer guidance, vari-rate fertiliser and chemical application). This was an update on the value, practical application, tackling field variability, and interpreting the data.

- Idiot's guide to analysing farm accounts – practical session on analysing annual profit and loss and balance sheets.

Taking up the challenge

Calculating the cost of producing a tonne of cereals is notoriously difficult especially on mixed farms but it is well worth the effort. The main problem is allocating fixed costs such as machinery and labour to the cereals on mixed farms with livestock, potatoes or even diversification enterprises. Actually the variable costs - seed, fertiliser and sprays - are easy to calculate being direct costs. There is little scope to reduce these inputs so in a way they are now 'fixed'.

The evidence

Part of the MF project also established a Benchmarking Group using the Home Grown Cereals Authority's 'Cropbench' which is freely available on their website. It runs on a simple spreadsheet and ensures a consistent approach. There are 12 growers in the Aberdeen benchmarking group who meet three times per year. Benchmarking and comparing yourself against other arable businesses is very powerful. It is a great way to identify areas that need to be improved and the route to improve performance and profitability. It is not often you get a chance to see real farm financial figures.

The actions

The Community Group felt that the cost of finishing cattle could be reduced by changing the balance of the diet away from purchased feeds and introducing more home grown feed of an improved dietary quality. In 2011, based on suggestions from the Community Group, the farm grew 10ha of peas and barley that were combined and treated with prop corn to be included in the TMR diet. The pea/barley straw was baled and also included in the TMR ration.

The outcome

Group chairman Peter Chapman, Redbog, Strichen said: "It has been very useful to have 12 of us working together and seeing the costs on different systems. Some use contractors while others have their own kit and some have expanded through contract farming so there can be big differences in costs between systems."

Some of the learning from the group is the identification of the three key factors which drive enterprise profitability – crop yield, average sale price (effective marketing) and controlling fixed costs (particularly machinery costs).

There have been surprises for the group, not least when it came to looking at machinery costs. Not only were these higher than expected they were also hugely variable between farms. Depreciation varied between £19 to £130 per hectare with the group average of £74/ha. Generally the supposition is that if machinery depreciation is high then repairs will be low and vice versa but this is not always the case. The farm with the highest depreciation charge had a repair bill of £86 per ha, whereas the farm with the lowest depreciation spent only £24 per ha (the average was £40/ha). Going round and visiting members' farms is invaluable and provides a practical understanding of the figures. There is no substitute for seeing things on the ground!

Average production costs for the group are provided in the following table. The main factor in 2012 was the reduction in yields. Note, rent and interest are not included in the estimate of production costs.

Production costs 2012 – excluding rent and interest.

	Sp Barley	W Barley	Wheat	OSR
Average yield (t/ha)	6.0	7.3	7.2	3.1
Average price (£/to)	£192	£172	£182	£384
Seeds	12	11	13	25
Fertilisers	33	36	37	87
Sprays	13	17	21	45
Sundries	1	1	1	1
Total Variable costs	£59	£64	£72	£159
Labour	23	22	23	48
Machinery	50	46	47	123
Property	7	6	6	17
Admin	8	7	7	20
Total Overheads	£89	£81	£83	£208
Production cost (£/to)	£147	£145	£155	£367

Source: Aberdeen Cropbench Group.

PEEBLESSHIRE MONITOR FARM

Date of first meeting: 7th November 2012
Name of Monitor Farm: Peeblesshire
Farmers' names: Kate and Ed Rowell
Farm name: Hundleshope
Address: Hundleshope, Peebles
Ownership: Tenanted
Farm size: rough grazing 585.5Ha,
permanent grass 96.10Ha, temporary grass 22.3 Ha,
spring barley 15.4Ha, arable silage 8Ha
Enterprises: 400 cross ewes. 250 Blackface ewes and 75 beef sucklers
Altitude: 200m to 685m above sea level
Facilitator:
Chris McDonald, 0131 5353436, chris.mcdonald@sac.co.uk
Jennifer Brown, 01835 823322, Jennifer.brown@sac.co.uk

Hundleshope is a mixed farm running 350 Blackface ewes on the hill and 400 cross ewes inbye. Blackies are tupped with Bluefaced Leicester and crossed with Texel, Charollais or Suffolk. The majority of lambs are sold fat. They also run 75 suckler cows put to the Charolais bull. All calves are sold store. Spring barley is grown for their own use. The family have been tenants of the Haystoun estate since 1868 and at Hundleshope since 1969. The business has farmed in the current partnership with Ed and Kate as main partners since 2005.

Main Monitor Farm topics covered in the year

- Lamb Finishing – Effective finishing of lambs indoors to maximise profitability and control liver fluke.

- Ewe Nutrition – feeding the pregnant ewe efficiently prior to lambing to ensure correct protein and energy balance. This included focussing on a source of high undegradable protein, which in this case was soya, and feeding this at levels of 15% of the mix, with home grown barley.

- Condition Scoring – managing condition of the ewe throughout the year to minimise use of concentrate feeds. A practical exercise was carried out on condition scoring and separating ewes according to condition maximising concentrate usage.

- Grassland/Reseeding – a discussion around the different methods which could be used to rejuvenate a poached pasture including soil compaction, surface reseeding and ploughing. Soil examination pits found that compaction was not an issue and that ploughing would be the preferred method of cultivation.

- Key Performance Indicators (KPIs) – Simple on farm recording for effective benchmarking. The group wanted a practical number of KPIs to record and agreed the following

  o Number of ewes/ram

  o Replacement rate

  o Scanning %

  o Number of lambs at 1st June

  o Number of lambs at weaning

  o Number of lambs sold/retained

  o Gross margins/ewe

- Ewe health – mineral supplementation as an aid to improving lambing %, specifically selenium following blood samples showing very low selenium levels. Ewes were treated with a selenium, copper, cobalt bullet and blood samples will be taken at key timings to assess the change on blood levels.

Taking up the challenge

Identify a strategy to finish tail end lambs indoors efficiently and profitably.

The evidence

Poor weather conditions and poor prices had left high numbers of lambs on the farm which would have normally been sold by August. Increasingly bad weather meant 300 lambs had to be brought inside. The lambs were not thriving since they had been brought indoors. All 300 lambs were running as one batch regardless of condition. The lambs were receiving 14.5% protein lamb finishing pellets on ad-lib hoppers, costing £250/tonne. Lamb price had fallen to just over 155p/kg liveweight (355p/kg deadweight) due to an influx of late finishing lambs as well as increased numbers being offloaded prior to the winter. There was evidence that fluke was a problem on the farm with losses to ewes and hoggs being sustained, and the cattle were also showing signs of fluke infection for the first time. This was confirmed by diagnosis. Due to the long withdrawal periods on flukicides (56 days for triclabendazole) the question was put to the group as to whether dosing these lambs was a feasible strategy, and the group was asked for any suggestions for improving lamb finishing.

The actions

The group had some varied suggestions as to how these lambs should be treated. Fluke information was provided by Dr. Philip Skuce of Moredun.

It was decided that the lambs would be better split into two groups. These lambs were to be assessed for body condition and estimated time from slaughter rather than weight. Lambs judged as further away from slaughter were dosed with a flukicide (Triclabendazole) and a clostridial treatment. The lambs closer to finishing were not dosed.

Splitting the group also allowed smaller lambs a better chance of getting to the feed and reduced bullying at the trough.

The group questioned the current policy of leaving lambs to reach their target weight of 42kg before selling. It was suggested that the benefit of the extra weight may be cancelled out by the additional feeding bought.

Table of calculations – extra feed to get to the extra weight.

*FCR	Cost of feed per Kg of gain
7	£1.75
8	£2.00
9	£2.25
10	£2.50

*FCR Feed Conversion Ratio

Feed at £250/tonne

It was also suggested that although they traditionally aim for 42kg lambs for the liveweight market it could be worthwhile investigating other options such as selling the lighter lambs to the European export trade

The outcome

There was an immediate benefit noted from splitting the lambs into two separate batches. Feed intakes increased as the smaller lambs were now separated and under less pressure from the larger lambs. Dosing lambs in poorer condition and further away from slaughter for fluke also helped to improve condition of the lambs.

Dr Philip Skuce of Moredun explained to the group how blood sampling lambs for fluke antibodies in the autumn was a good way of testing for infection and could give a reliable idea as to whether or not to treat lambs early on.

Lamb Prices 2013

Date sold	no. sold	ave. dead wt (kg)	ave. p/kilo
24/01/2013	102	18.76	£3.21
31/01/2013	65	16.98	£3.25
05/02/2013	37	15.32	£3.16

Although the season had a huge impact on when the lambs were finished the group agreed that it would be a priority to finish as many lambs as possible off grass. This year lambs will be divided into two groups with one group of lambs receiving creep feed from an early age. Lambs will be weighed at weaning and the dates of sale noted as a comparison.

Lambs will be blood sampled for fluke antibodies in late summer to assess risk and decide whether lambs should be dosed or not based on product withdrawal, time and length of time to sale.

PIG MONITOR FARM

Date of first meeting: 21st November 2012

Farmers' names: Danny and Alison Skinner

Farm name: Lazyfold Farm

Address: Duncanstone, Insch

Ownership: Family partnership

Farm size: 170ha in total, 122ha owned and 48ha seasonal let.

Enterprises: 440 sows indoor production.
All the land is down to cereals for pig feed.

Altitude: 200m above sea level

Facilitator:
Jim Booth, 01651 843607, jim.booth@saos.co.uk
Jamie Robertson, 07971 5645148, j.roberston@abdn.ac.uk

Lazyfold is a family business which specialises in pig production. The dedicated pig unit extends to 440 sows on an indoor breeding-to-finish system. The family operates a closed herd producing own gilts based on Large White X Landrace criss-cross using AI. All the 170ha is in cereal production. The majority of feed is home mixed, half of the cereals being produced at home with the balance, 1,200t, purchased. Pigs are sold at bacon weight, all marketed through Scottish Pig Producers (producer co-op). The Skinners have invested over £300k over the last two years in new weaner accommodation and additional slurry handling facilities. The business employs three staff, all in the pig unit.

Main Monitor Farm topics covered in the year

This is the third Pig Monitor Farm and having just recently been launched has only had two meetings to date.

- Project launch – getting to know the business, reviewing herd performance and getting the group to assess Lazyfold's strengths, weaknesses and potential areas for improvement.

- Identifying and quantifying the factors that are limiting Lazyfold's performance and overall unit profitability.

- In addition, they have established a strong Management Group which has met twice to plan future meetings, identify areas to monitor/measure, and generally support the Skinners.

Taking up the challenge

Where are 'the low hanging fruits'? Identifying the factors that limit the theoretical output from a pig unit is crucial when striving to improve profitability. Potentially there are lots of things that could be improved, however, the starting point is to first quantify the impact of key factors on the unit's performance and profitability, and to tackle the easy wins – "the low hanging fruit!"

The Skinners' unit at Lazyfold is already a highly productive unit, easily in the top 25% in the country so the group were not expecting to find lots of potential areas for improvement – see Table 1 for the latest quarterly performance.

Table 1: Lazyfold's Performance (Oct-Dec 2012)

Litters per sow /year	2.36
Pigs weaned per sow /year	27.5
Born alive per litter	13.6
Pre-weaning mortality	13.7%
Farrowing Rate	91.3%
Post-weaning mortality	4.9%
Av liveweight at sale	104kg
DLWG (weaning-finish)	651g
FCR (weaning-finish)	2.24
Total dwt produced per sow /year	1,900kg

The evidence

To identify the limiting factors, use was made of the data from the Aberdeen Pig Benchmarking group of which the Skinners are members. Five areas (see Table 2 below) were identified as potential for improvement by comparing Lazyfold not against a theoretical target but importantly against actual pig units in the region.

Table 2: The potential for improvement at Lazyfold

Factor	Lazyfold	Group	Extra Margin	Value /kg sold
Pre-weaning Mortality	13%	10%	£14,200	+1.6p/kg
Weaning weight	7.6kg	8.1kg	£11,500	+1.3p/kg
Rear-finish FCR	2.44	2.40	£12,400	+1.4p/kg
Selling Wt	78.6kg dwt	83kg dwt	£19,000	+2.2p/kg
Av Feed cost	£286/t	£250/t	£93,500	+10.8p/kg
Total			£150,600	+17.5p/kg

The outcome

The results were astonishing. Even for a unit like the Skinners, there was potential to increase the bottom line by up to £150,600! Admittedly, this is a simplistic view as many of the factors have subsequent knock-on effects elsewhere in the unit, plus to keep pigs to higher weights would need investment in additional buildings, however, it shows the scale of the potential benefit. There is no other enterprise in farming so responsive to improvements in management and performance as pigs. Imagine if this is possible for Lazyfold, which is a top unit. What is the potential for other producers?

ORKNEY MONITOR FARM

Date of first meeting: 30th May 2012

Name of Monitor Farm: Orkney

Farmers' names: Steven and Lorraine Sandison

Farm name: Millburn

Address: Millburn, Harray, Orkney. KW17 2LA

Ownership: Own 92.82ha Rent 38.3ha

Farm size: rotational grass 78.71ha, permanent grass 21.76ha, rough grazing 10ha, spring barley 12.94ha, arable silage 7.71ha.

Altitude: Sea level – 125m above sea level

Enterprises: 100 spring calving suckler cows with the offspring sold as weaned calves in October.

Facilitators:
George Baikie, 01856 872698, george.baikie@sac.co.uk
Graham Scott, 01856 872698, graham.scott@sac.co.uk

Millburn is a 130 hectare mixed grassland/arable farm operated by Steven Sandison and his wife Lorraine. It supports 105 continental cross cows which calve in spring to Charolais, Simmental and Salers bulls. All the offspring, except the replacement heifers, are sold as weaned calves in October.

Main Monitor Farm topics covered in the year

- The use of EBVs and MOTs to aid bull selection and management.

- Millburn's missing kgs. Why have the weights of the weaned calves dropped significantly over the last three years? There were several factors which were influencing the decline in weights to varying degrees. The main contributors were:
  (1) an increase in stock numbers coupled with a drop in grass area. i.e. less grass per head.
  (2) Change in cow genetics through moving away from an almost pure Simmental cow to a Simmental X.
  (3) Poor weather in 2011 and 2012.

- Assessing the pros and cons of introducing calf creep feeding at Millburn through undertaking a mini trial on 24 Charolais X heifer calves and their dams. The trial showed creep feeding not to be cost effective at Millburn as the value of the extra weight gain (£12.25) was out-weighed by the cost of feed per calf (£44.20).

- Herd health plans. What should they cover and how can they play a role in improving the performance of the Monitor Farm? The main message from the day was that the more comprehensive and accurate the data you record, the easier it is for a vet to make informed, constructive comments to improve your farming system.

- Fertiliser and lime policy. Through the analysis of the soil and slurry at Millburn, can changes be made to improve soil fertility and yields? The day highlighted the areas of the farm which required remedial action in terms of phosphate and potash applications. Areas of low pH were also highlighted, with emphasis placed on ascertaining the neutralising value (NV) of shell sand to avoid under/over liming.

Taking up the challenge

Millburn's system is relatively uncommon in Orkney as all of the calves are sold once they are weaned at around 7-8 months of age. Selling at this young age on a kg basis heightens the importance of achieving good daily liveweight gains during the grazing season.

The evidence

Analysis of recent weaning weights at Millburn (Table 1) revealed that they were in decline and that steps should be taken to identify the reasons for this loss and to reverse the trend. As a result, the Community Group decided that creep feeding should be introduced on the farm.

Table 1. Weaning weights of steer calves in 2010 and 2011.

	2010	2011
Average (kg)	346.33	330.73
Number of calves	40	44

The actions

Twenty four Charolais X heifer calves and their mothers were weighed and split into two separate groups of equal weight on 17th August. The calves' weights averaged exactly 197kg in both groups whilst the cows averaged 655kg in the creep fed group and 659kg in the other. They were both grazed on very similar blocks of land, however one group was provided with creep feed based on a mix of barley and 17% protein beef nut.

The outcome

The calves were weighed three times as shown in Table 2. On re-weighing the animals at weaning (19 October) it was found that the creep fed group had only gained 5.83kg more than the unfed group. This failed to cover the cost of the feed which they had consumed (£44.20/calf) which resulted in a net loss of £31.95 per calf.

The cows were also re-weighed at this time which surprisingly revealed that those which suckled the creep fed calves put on less weight (23kg) than the unfed group (43kg).

After weaning Steven sold all his calves as normal. However, we were fortunate that the farmer who bought all of them was agreeable to weighing them once more on 1st December. These results were more favourable for the pro creep feeding camp as each calf in the creep fed group gained an extra 27.5kg compared to 18.5kg since weaning.

Both groups had received exactly the same ration since housing which consisted of silage, barley, Amino beef, Champion 35, beef minerals and Limestone flour.

Although the creep feeding had significantly reduced check at weaning, the financial outlay in terms of feed (£44.20/calf) was still not covered by the value of the extra gain in liveweight (£31.50/calf) which resulted in a net loss of £12.70 per calf.

The calves will be re-weighed before turnout thanks to the co-operation of Mervyn Sandison of Hindatoon.

"If you have measured it, you can manage it." (Bob Norquay – Vet)

Table 2. Affect of creep feeding on the weight of 24 of Millburn's charolais x heifer calves

Creep fed

	Calf Tag	Calf weight		
		17 Aug	19 Oct	December
1	554	155	250	290
2	550	160	245	280
3	553	170	260	280
4	494	180	250	295
5	524	190	290	325
6	540	195	285	310
7	531	205	300	320
8	522	215	310	325
9	516	215	320	335
10	521	220	315	350
11	519	230	325	345
12	459	230	325	355
Total		2365	3475	3810
Average		197	290	317.5
			(+93)	(+27.5)
				120.5

Not fed

	Calf Tag	Calf weight		
		17 Aug	19 Oct	December
1	547	155	250	270
2	545	165	255	270
3	544	170	250	270
4	518	185	305	325
5	487	195	260	275
6	528	195	270	285
7	537	200	300	320
8	546	215	310	340
9	460	215	290	305
10	527	215	295	315
11	451	220	300	315
12	481	235	320	340
Total		2365	3405	3630
Average		197	284	302.5
			(+87)	(+18.5)
				105.5

The cost of the feed used in the trial:
920 kg barley @ £150/t = £138
1330 kg nuts @ £265/t = £352.45
Biocel Yeast = £40
TOTAL = £530.45 (£44.20 per calf)

From 17 August to 19 October (weaning) the 12 calves in the creep fed group gained an extra 70kg in total compared to the unfed group (5.83kg each).

@ £2.10/kg this equates to a gain of £12.25 per calf.

When subtracting the cost of the feed (£44.20) each calf lost on average £31.95.

From 17 August and 1 December the 12 calves in the creep fed group gained an extra 180kg in total compared to the unfed group (15kg each).

@ £2.10/kg this equates to a gain of £31.50 each.

When subtracting the cost of the feed (£44.20) each calf lost on average £12.70.

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