Agri-Food and Biosciences Institute

DAIRY INNOVATION 2018

PROFITING FROM AFBI RESEARCH

INTRODUCTION

Welcome to the Agri-Food and Biosciences Institute's Dairy Open Day - 'Dairy Innovation in 2018 – Profiting from AFBI Research'. This event, which has been organised in partnership with AgriSearch and CAFRE, will demonstrate how the latest scientific research is seeking to provide solutions to many of the current challenges within the local dairy sector.

This Open Day is taking place at a time of unprecedented change and challenge. On a global scale, challenges include increased food demand to meet the needs of an increasing population, climate change, and associated pressure on land and water resources. Locally, challenges being faced by the Northern Ireland dairy sector are many and diverse. These include:

- volatility in milk prices
- potential fodder shortages next winter
- sub-optimum fertility and cow health
- bovine tuberculosis and new and emerging cattle diseases
- antimicrobial resistance and future limitations on antibiotic usage
- need for greater efficiency in concentrate use
- need to optimise grassland management and productivity
- need to reduce phosphorus, ammonia and greenhouse gas emissions to protect and improve the environment
- uncertainty associated with the UK's exit from the European Union
- concerns about animal welfare
- increasing retailer and consumer pressure
- shortage of skilled labour

While some of these challenges are outside of our control, the development of robust production systems can help ensure that farm businesses are more resilient to these outside pressures. Nevertheless, many of the challenges can be controlled, or mitigated in part, through the application of research findings and improved management strategies on farms. For example, improving soil and grassland management will allow more grass to be grown and utilised, reduce feed costs, and thus help negate fodder shortages next winter. Similarly, the use of appropriate cow genotypes can improve cow fertility and health, while improved biosecurity precautions can reduce the risk of a disease breakdown. Improved cow health will also reduce the need for antibiotic use, save on veterinary costs, and reduce the likelihood of antimicrobial resistance developing. Overall improvements in production efficiency, including a renewed focus on milk from grass, will reduce the environmental footprint of dairy systems.

Solutions to many of these challenges have been, and are being developed through AFBI's research, and the outcomes of a number of these scientific programmes will be on display at Dairy Innovation 2018. The primary objective of this Open Day is to share the latest research knowledge and developments in innovation, and to demonstrate how this can be applied to improve technical efficiency and reduce costs on dairy farms.

The first part of the Open Day involves a structured tour which will focus on six key research themes.

- The first four themes focus on the efficient production and utilisation of grass, one of Northern Ireland's key natural advantages, and one we must fully capitalise on if we are to remain competitive in the future. This applies irrespective of cows producing 5000 litres or 12000 litres per lactation.

While we have the ability to grow high yields of grass (up to 15t DM/ha) at relatively low cost, this requires that soils are managed correctly and nutrients are applied to meet the requirements of the growing crop. Furthermore, grass that is grown must be utilised efficiently, and this involves optimising grazing intensity, while meeting the nutrient requirements of higher yielding cows. While targeted use of concentrate supplements plays a key role within these systems, high levels of milk from forage should remain a key objective. In addition, looking to the future, new technologies are likely to revolutionise grazing systems, with developments in grass measurement and budgeting systems, linked with cow location sensors leading to the potential for fence free grazing platforms.

While grass silage is also a key component of grassland systems, silage quality has improved little over the last two decades within Northern Ireland, and this has prompted the development of a new research programme into the production and utilisation of high quality silage. Silage quality is particularly important given that concentrate feeds comprise 60 - 70% of variable costs on local dairy farms, and high quality silage, combined with the appropriate use of concentrate supplements during the winter offers real opportunities to reduce feed costs.

- The sixth theme will focus on the environment, and highlight how AFBI is contributing to an improved knowledge of strategies to reduce ammonia emissions from dairy systems.

- The fifth theme will focus on protecting herd health, and will in particular highlight AFBI role in tuberculosis, IBR and BVD control, as well as the importance of farm biosecurity.

In addition to the six main stops, four focus areas have been established and will include exhibits on Grassland Management, Anaerobic Digestion and Slurry Separation, 'Heifer Rearing and Cow Genetics', and Animal Health and Welfare.

Finally, the central marquee will feature many other demonstrations related to broader AFBI research, including the economics of milk production, enhancing food quality, silage analysis, disease resistance and reducing methane losses.

This booklet provides a summary of many of the key areas of research that are on-going within AFBI, and that will be on-show during the open day, and highlights the contribution that underlying science makes to sustaining and strengthening the local dairy sector. I encourage you to discuss the work being presented today with AFBI, AgriSearch and CAFRE staff who will be available throughout the day.

Research undertaken by AFBI would not be possible without the financial support from DAERA, from the industry levy which is administered through AgriSearch, EU grant funding, Agri-Food Quest, and a wide range of other funders. Their support is gratefully acknowledged.

Finally, I would like to thank all staff from across AFBI who have worked tirelessly to make this event a success.

Sinclair Mayne

Sinclair Mayne
AFBI Chief Executive

THE AFBI DAIRY HERD

A BRIEF OVERVIEW

Mike Davies, Debbie McConnell, Steven Morrison and Conrad Ferris

Background

The AFBI Hillsborough dairy herd comprises approximately 340 dairy cows and 180 young-stock. While the cows within the herd are predominantly Holstein-Friesian, there are also a number of crossbred cows which were derived from past research programmes on crossbreeding. The herd is a 'research herd', whose primary role is to facilitate a diverse range of research studies examining issues of relevance to the Northern Ireland Dairy Sector. Approximately 40% of cows calve in the autumn and 60% of cows calve in the spring. Cows within the herd are normally split into 10 - 15 separate groups to facilitate the experiments being undertaken.

Genetic merit

The Holstein component of the herd has a Profitable Lifetime Index (£PLI) of £366, and is ranked within the top 1% of UK herds for PLI. The ranking of the herd for other parameters, compared to the current UK breed average, is shown in Table 1. The values highlight that while the herd is ranked within the top 25% for milk volume, it is ranked within the top 1% forkg of fat andkg of protein. In addition, the herd is now ranked within the top 20% of herds for lifespan, the top 5% for somatic cell count, the top 15% for fertility index, and the top 20% for mastitis. These values reflect the sire selection policy which was adopted during the last decade. The annual improvement in the PLI of animals, from calves through to those in their fifth lactation, is presented in Figure 1.

Table 1 Genetic averages for the AFBI Hillsborough dairy herd, and percentage positioning of the herd for each of these traits, compared to the current UK breed average

	AFBI Herd average	Position compared to breed average in the UK
£PLI	366	Top 1%
PTA Milk (kg)	258	Top 25%
PTA Fat (kg)	16.0	Top 1%
PTA Protein (kg)	13.7	Top 1%
PTA Fat (%)	0.07	Top 10%
PTA Protein (%)	0.06	Top 5 %
Lifespan	0.26	Top 20%
SCC	-9.3	Top 5%
Fertility Index	5.7	Top 15%
Inbreeding	4.8	Top 65%
Mastitis	-1.2	Top 20%
Maintenance	1.3	Top 25%

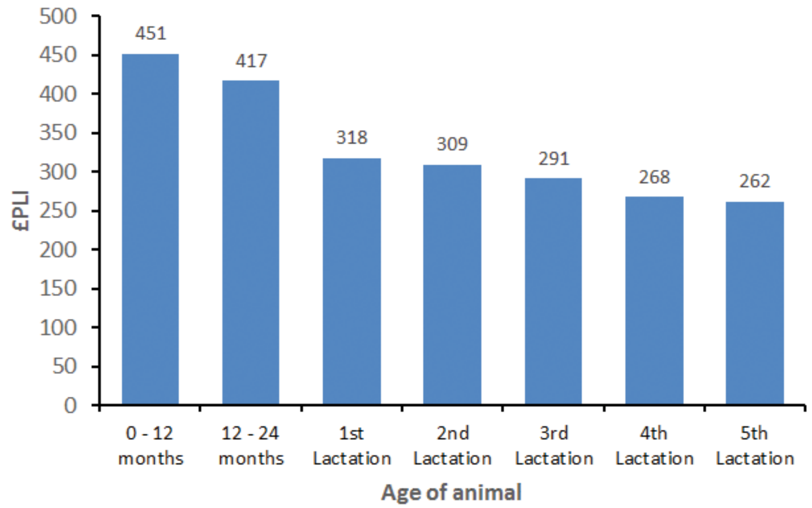


Figure 1 Profitable Lifetime Index (£PLI) of animals within the AFBI dairy herd, presented by age structure and lactation number

Breeding and sire selection

All cows in the herd are bred using artificial insemination, with insemination undertaken by AFBI staff following morning milking. Cows observed in heat the previous day, including during evening herd check, are inseminated between 8.00 and 9.00am the following day. All cows are allowed a 42 day voluntary waiting period, with breeding for the autumn calving component of the herd commencing during the first week in December, while breeding for the spring calving component of the herd commences during the first week of April. Calving commences early September and continues until the end of March.

The long term breeding objectives are to maintain the herd within the top 1% of UK herds for PLI, while improving functional traits and milk composition. Sires selected are normally within the top 10 - 15 highest ranked sires for PLI. However, a number of essential secondary criteria are applied, namely that sires used must have a reliability of greater than 75%, positive deviations for fat and protein percentage, be positive for fertility and negative for somatic cell count. In addition, the following 'desirable traits' are applied, namely positive for lifespan, positive for TB advantage, and have a PTA for milk of >200kg. Sires used on heifers are also selected for calving ease.

The level of inbreeding in the herd is currently 4.8%, and as such 'outcross' sires are used when possible. Genomic sires have been used within the herd for the last 5 years, and normal practice within the winter and spring calving components of the herd is to use 3 conventional tested sires on approximately 60% of the herd, and a team of 3-4 genomically tested sires on the remainder of the herd. Similar criteria are applied to the selection of genomically tested sires, except that a reliability of 65% is adopted. Once sires have been selected, they are assigned to individual cows to ensure that levels of inbreeding do not exceed 6.25%. Easy calving beef sires are used on the herd during the final 3-4 weeks of the breeding season.

Calf and heifer rearing

Calves born from the dairy herd are reared within the young stock facility located at AFBI Hillsborough. Best practice procedures relating to colostrum management, health plans and hygiene standards have been developed to help reduce the risk of calf ill health. Transfer of calves to the calf rearing accommodation occurs within 12 hours of birth with colostrum feeding continuing for up to 7 days, depending on the research requirements.

Individual bucket, group and computerised milk feeding systems are available to the calf research group complemented by bespoke precision concentrate feeding systems and in pen animal weighing equipment. The nutritional management of the young-stock herd is determined largely by the requirements of ongoing research programmes, with studies being conducted both pre and post weaning. By 12-16 weeks of age the calves are typically relocated to the post wean calf cubicle house or the grazing platform.

Heifers are reared to calve at 23-24 months of age at approximately 580kg, and with a body condition score of 3. Breeding is by artificial insemination by trained AFBI technicians and commences from 13.5 months of age with weight gain monitored weekly, both indoors and during the grazing season, to ensure heifers achieve their weight for age targets. Heifers are typically transferred to the dairy cow facility 3-4 weeks prior to expected calving date.

In consultation with the veterinary team a comprehensive vaccine plan has been developed and is continually reviewed. Vaccines used include those relating to: common pneumonia pathogens such as Bovine Respiratiory Syncytical Virus (BSRV), Parainfluenza3 virus (PI3), Mannheimia haemolytica; clostridial diseases such as blackleg; fungal infections such as ringworm; leptospirosis and Salmonella. Bespoke parasite control plans aligned to herd management have also been developed in partnership with the veterinary team.

Milking routine and current herd performance

The herd is milked twice daily though a 50 point rotary milking parlour (Boumatic, Daytona), which was commissioned in 2004. A rotary parlour was chosen for a number of reasons, including the fact that it facilitates ease of management of multiple small groups of cows, and that it allows up to four concentrate types to be offered at a single drop point. Most, but not all cows are offered concentrates in the parlour. Morning and evening milking commences at 5.00 am and 3.00 pm, respectively, and normally takes between 1.5-2.5 hours, depending on the number of cows being milked at that time. Each milking is undertaken by three members of staff. One member of staff prepares the cows, a second member attaches the clusters, and a third member brings cows to and from the parlour, in their research groups. Teats are dipped, dry wiped and stripped pre milking, and automatically sprayed post milking. While the parlour has the capacity to milk 220 cows per hour, this maximum rate of throughput is not possible due to the multiple groups of cows that move through the parlour. The herd participates in monthly milk recording, and all cows are automatically weighed after each milking.

Total milk sales from April 2017 - March 2018 were 2.544 million litres, with milk produced having a mean fat content of 4.28% and a mean protein content of 3.38%. Average somatic cell count over the same period was 115, 000 cells/ml, while the average bacto-count was 18. As a consequence of good compositional and hygienic quality, the price received for each litre of milk was 2.1 pence per litre above base price. This level of production represents an average annual milk sold per cow of 7750 litres. However, this level of performance varies greatly depending on experiments that cows are managed on, with average performance within studies involving low concentrate input systems being around 6000 litres, while average performance of cows managed on higher concentrate input systems is around 9500 litres per cow.

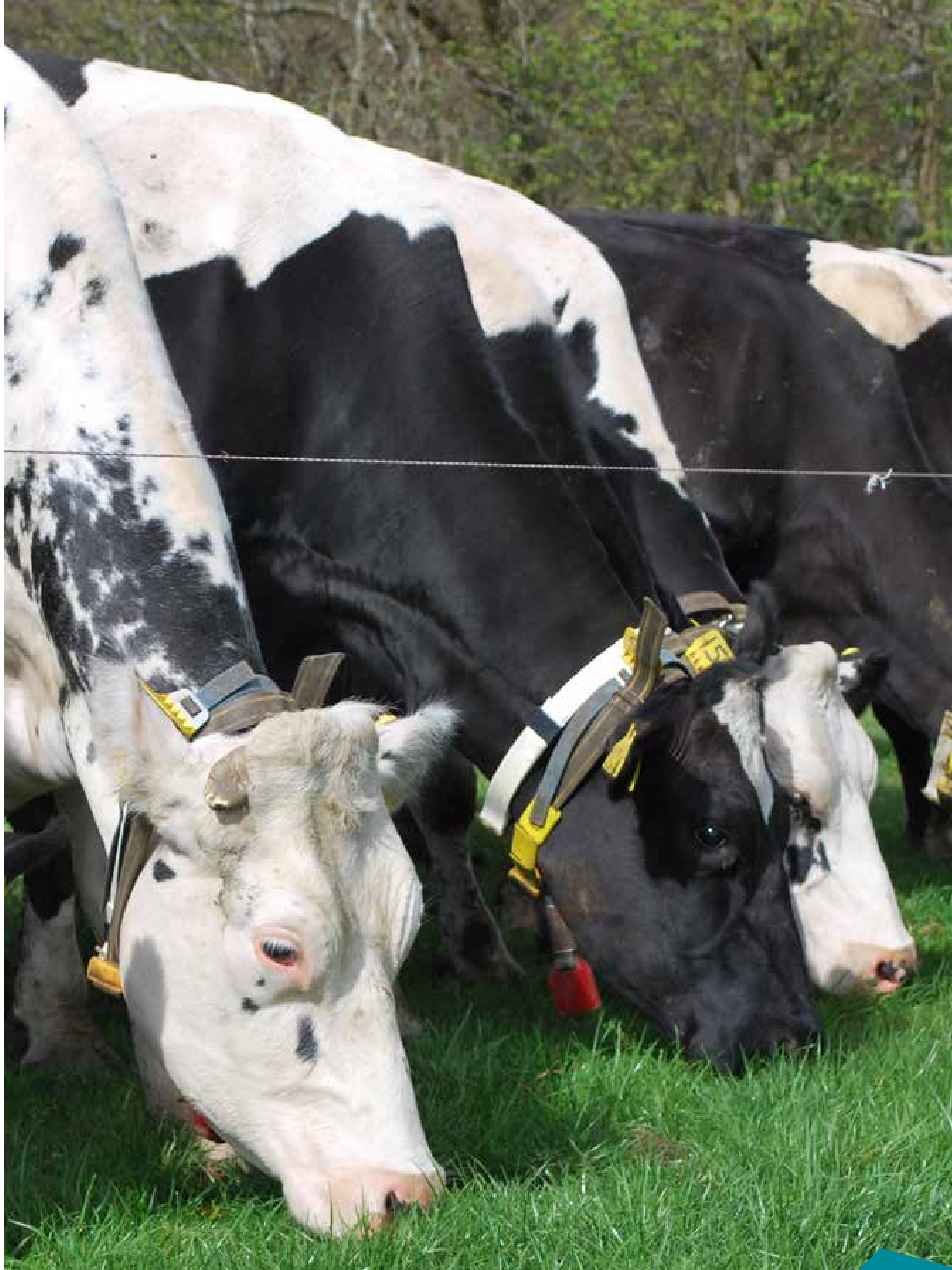
Nutritional management of the milking herd

The nutritional management of the herd is determined largely by the requirements of ongoing research programmes. Cows which calve in the autumn are predominantly used within winter feeding research programmes, and offered grass silage based diets. Neither maize silage nor whole crop silage is currently included in the diet of the milking herd. Concentrates are offered using either in-parlour feeders, out-of-parlour feeders, via a mixer wagon, or by a combination of these approaches, depending on research requirements. The spring calving component of the herd is normally used within grazing research programmes, with concentrates normally offered in parlour. Total concentrate inputs over the course of any single lactation may range from 0.6 t through to 3.5 t/cow, depending on current experiments. Cows may be managed on 2-3 different experiments within the course of a single lactation, and nutritional strategies for any individual cow may vary greatly from one year to the next, and even within a single year. Being able to record individual cow intakes is critical in many research programmes, and recent investment (by DAERA and CIEL) has facilitated the purchase of sixty-four new feed intake monitoring stations. These allow intakes of over 140 cows to be monitored at any one time. A 48 ha grazing platform is available to the dairy herd. Fields are sampled on a regular basis for soil fertility, with the current platform averaging a pH of 6.2, phosphorus index of 3, and a potassium index of 2+. Swards are predominantly perennial ryegrass - white clover mixtures (65% diploid, 35% tetraploid) with a target of 15% of the grazing platform reseeded annually. Target fertiliser nitrogen inputs within the grazing system are normally 270kg nitrogen per ha, applied as urea in spring and CAN throughout the summer months. Grass is measured on a weekly basis to establish a grass wedge with excess grass removed for silage. Target pre- and post-grazing covers are 3200 and 1700kg DM/ha, respectively. Target turnout is the 15 March however in 2018 turnout wasn't achieved until 10 April due to very poor ground conditions. Rotational grazing systems are normally adopted, although these may involve fixed paddocks or flexible herbage allocations, as required by the research programme.

Herd health

Having a herd with a high health status is essential for the success of all research programmes, and as such the herd management team strive to maintain excellent herd health through the combination of good biosecurity practices, and proactive health management. As with the young stock, in consultation with the herd's veterinary team, a comprehensive vaccine plan has been developed and is continually reviewed. Cows are vaccinated for Salmonella, IBR, BVD and Leptospirosis. In addition, vaccination for Schmallenburg will commence in May 2018. The herd is treated for worms during the autumn, with timing year dependent, while all cows are treated for fluke at drying off. Hoof health is maintained through regular foot trimming, and by foot bathing 4 times weekly when cows are housed, and weekly during the grazing period. Cows have traditionally been treated with dry cow antibiotics and a teat sealant at drying off. However, this year the herd will move to targeted use of dry-cow antibiotics based on individual cow mastitis history and somatic cell counts, while all cows will continue to be treated with a teat sealant.

50 point rotary parlour at AFBI Hillsborough



DAIRY HEIFER REARING

TARGETS FOR LIFETIME PERFORMANCE

Ruth Kinkead and Steven Morrison

Key Messages

- It is essential to achieve calving by 23-24 months of age to minimise rearing costs, maximise lifetime production and improve fertility with reduced calving intervals.
- To achieve this, target weight for age must be met throughout the rearing period.
- AFBI have developed rearing targets and tools to help producers stay on track for 24 months calving at optimum weight.

Background

The age at which a heifer calves for the first time and joins the dairy herd is a major driver in the cost of a dairy herd replacement. Delayed calving beyond 24 months of age has been shown to cost an additional £2.87/day and may contribute to negative effects on longevity, fertility and animal health. Indeed studies show heifers that calve by 24 months demonstrate improved fertility and enhanced lifetime performance compared to older heifers. CAFRE benchmarking data indicate that a dairy heifer costs on average £1768 to rear until the point of calving (or 5-6ppl milk produced) therefore we must ensure these animals are reared efficiently to enable maximum return on their investment

Targets

Weaned dairy calves typically weigh between 70 and 100kg by 8-10 weeks of age. The next target to achieve is puberty since heifers must be ready for breeding. Research shows that the age of puberty onset is strongly influenced by growth rate. Therefore, a minimum growth rate is required to ensure heifers are pregnant by 15months of age. If we assume a mature cow weight of 630kg for Holstein dairy replacements, Table 1 outlines the required growth rates/weight for age targets to achieve 24 month calving.

When you are on track to meet weight for age targets and have successfully bred the heifer the next step is to ensure growth targets are sustained to calving. Previous on farm research conducted by AFBI, showed that a moderate calving down weight was optimal for lifetime performance. A summary of the results is shown in Table 2. In brief the larger heifer at calving tended to (but not always) produce an increased peak milk yield milk but mobilised more condition in early lactation with negative impacts on fertility and lameness. Over the lifetime of the heifer the moderate weight (540-570kg) at first calving provided optimum milk yield with reduced incidence of lameness.

Table 1 Example weight for age targets within a 24 month age at first calving rearing programme

Age (months)	Weight (kg)	Daily weight gain (kg/d)	Weight as percentage of mature weight (%)
0 (birth)	40		
3	107	0.78	17%
6	170	0.77	27%
14	347	0.77	55%
24 (pre calving)	567	0.77	90%

Table 2 Summary of AFBI Studies on optimum weight for calving heifers

	Moderate Heifers	Large Heifers	Milk yield (moderate v heavier heifers)	Others
Study 1	570kg	620kg	No difference	Larger heifers lost more body condition after calving
Study 2	540kg	620kg	1st lactation: 11% lower (800 litres) 2nd lactation +: No difference Overall: No difference	Shorter calving interval (30 days+) and lower incidence of lameness in moderate heifers
Study 3	540kg	620kg	1st lactation: Peak yields lower 2kg/day, but no overall difference 2nd lactation+: No difference Overall: No difference	Larger heifers lost more body reserves after calving
Study 4	550kg	600kg	1st lactation: Peak yields lower 3kg/day, but no overall difference 2nd lactation+: No difference Overall: No difference	Shorter calving interval (40 days+) and lower incidence of lameness with moderate heifers

How to monitor and manage dairy heifer growth?

Measuring the growth and development of dairy heifers against appropriate targets is the key to success in heifer rearing. AFBI have developed two major tools to assist dairy producers to successfully calve heifers at the optimum body size and age.

Firstly, a calibrated weigh band permits producers to determine accurate weights for their heifers. This recognises the fact that less than 10% of producers have weighbridges available to record heifers through the various rearing phases (AFBI/CAFRE survey). With over 21,000 animal recordings used to calibrate the weigh band, this tape gives a robust and reliable prediction of the live weight of Holstein-Friesian heifers. The weigh band has been distributed to many countries worldwide and is currently available from your CAFRE dairy advisor

Secondly, AFBI have developed the BovIS Growth Monitoring Tool within DAERA online services. This intuitive web based programme enables easy monitoring of growth rate through the rearing period against targets set from the latest AFBI research. The Growth Monitoring Tool returns from APHIS a list of available animals within the user's herd that meet the date of birth range selected. Based on the mature weight of the cows within the herd, a customised growth curve is generated against which the inputted animals' weights are assessed. The producer can clearly see how the individual or group of animals are performing against target and make an informed decision on how to best achieve the next target.

Farming guidance

Within the dairy industry there are significant opportunities to reduce the average age of calving towards the 24 month target, through the appropriate management and feeding.

This will have significant economic (estimated at 1ppl savings in the cost of production) and environmental benefits (estimated 5% reduction in greenhouse gas emissions). AFBI research and the decision support tools such as the weigh band and BovIS growth tool are designed to help the dairy industry realise these opportunities.

BREXIT IMPACTS ON THE DAIRY SECTOR

John Davis, Myles Patton, Claire Jack and Siyi Feng

Key Messages

- AFBI economists have shown that different possible post-Brexit trading relationships would have substantially different impacts on local producer milk prices
- Regardless of the trading mechanism, improved efficiency is a key priority for global competitiveness in milk production
- AFBI's economic studies have shown that moderate input-moderate output production systems are robust and resilient over a wide range of milk and commodity prices

Background

The dairy sector has experienced considerable volatility in recent years, with substantial swings in commodity and producer milk prices. Brexit and the UK's future trading relationships with the EU will have further implications for the dairy sector in Northern Ireland, depending on the trade deals that are eventually agreed. Analysis undertaken within the Agricultural and Food Economics Branch of AFBI has quantified the potential impacts on the local dairy sector of three possible Brexit trade scenarios: a "soft Brexit" scenario i.e. a bespoke free trade agreement (FTA) with the EU; and two contrasting "hard Brexit" options, namely a high tariff World Trade Organisation (WTO) Default scenario and a Trade Liberalisation scenario with zero tariffs applied to dairy imports to the UK.

Bespoke Free Trade Agreement with the EU

This scenario is in line with the goals for an ambitious and comprehensive FTA and a new customs agreement as outlined in the government's Brexit White Paper. The estimated impact on the NI dairy sector is relatively small since this scenario entails minimal disruption to trade (Figure 1).

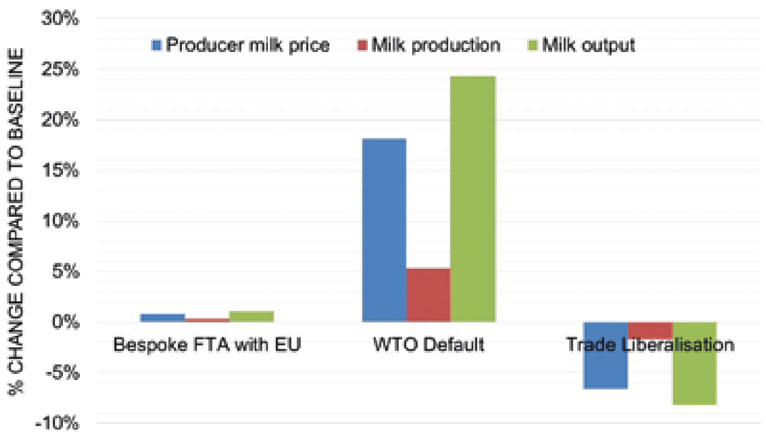
World Trade Organisation Default

In the absence of a Free Trade Agreement between the UK and the EU, the UK would be required to fall back on WTO default tariffs, at least in the short-run. Under this scenario, the default tariffs are applied on UK exports to the EU and likewise on imports from the EU to the UK. The tariffs are very high, leading to significant disruptions to trade between the UK and EU-27.

Trade Liberalisation

In order to avoid applying the high WTO import tariffs, the UK could potentially opt for unilateral trade liberalisation, where tariffs on imports from the EU and the rest of the world are reduced. This radical version of unilateral trade liberalisation is where the UK sets zero tariffs on imports to the UK from both the EU and the rest of the world. This scenario has a depressing impact on dairy commodity prices but the extent of the price reductions is constrained by the levels of world dairy commodity prices. Under this scenario the Northern Ireland producer milk price and output value fall by 7% and 8% respectively (Figure1).

Figure 1: Projected Changes in the Dairy Sector in NI under Trade Scenarios



Robust milk production systems

Regardless of the new trading relationships the requirements for improved efficiency to underpin our global competitiveness in milk production will remain a key priority for the sector. Previous research within the Agricultural and Food Economics Branch of AFBI has used computer-based economic modelling techniques to identify robust milk production systems that are particularly suited to the production conditions that apply in Northern Ireland. In managing their resources dairy farm operators must make important decisions about land use, enterprise mix, feeding systems, calving dates, family labour availability, finance etc. The purpose of our economic research, which was undertaken in consultation with AFBI scientists and other stakeholders, was to identify profit maximising whole-farm systems which were robust under conditions typically experienced in Northern Ireland.

The robustness and resilience of the range of dairy production systems that we analysed were tested by incorporating changes in three key variables:

1) Producer milk prices
2) Concentrate prices
3) Fertiliser prices

Results from our simulations were consistent across a range of milk and input prices. Farm incomes, of course, varied considerably depending on the level of milk prices. However, the typical optimal systems changed hardly at all:

- either a spring calving herd, yielding an average 7,000 litres per cow
- or an autumn calving herd, fed grass and maize silage, yielding an average 8,000 litres per cow

In other words, moderate input-moderate output milk production systems were shown to be economically robust and resilient over a wide range of milk, concentrate and fertiliser prices.

Farming guidance

These economic research assessments indicate that the optimal dairy system for typical Northern Ireland dairy farms is somewhere between the extremes of the relatively intensive systems adopted in the 'U.S. style' high input, high output systems and the New Zealand style low input, low output systems, both of which were found to be less versatile and robust under typical Northern Ireland farming conditions. This economic research has played an important decision support role in helping farmers, agricultural researchers, advisers and agricultural policy makers identify economically sustainable livestock production systems for Northern Ireland. AFBI's Agricultural and Food Economics Branch is has plans to re-establish this work on sustainable dairy farm modelling in light of future potential changes in market dynamics.

Footnote:

1. The reported results on the dairy farm-level models are based on research undertaken by AFBI Economist Dr Duncan Anderson who has since retired

2. AFBI Acknowledges the funding support from DAERA, Defra, the Welsh Government and the Scottish Government

MANAGING COLOSTRUM VARIABILITY

NOT ALL COLOSTRUM IS EQUAL

Ruth Kinkead, Barbara Waters, Amanda Dunn, Bernadette Earley, Michael Welsh & Steven Morrison

Key messages

- Quality of colostrum produced on farm is highly variable and should be tested regularly to confirm it is sufficient to provide immune protection to the calf
- Colostrum should be collected immediately after calving (within 6 hours) to acquire high quality colostrum (>50g/L immunoglobulins)
- Ensure colostrum is stored in a refrigerated environment to reduce bacterial growth and high standards of hygiene are maintained through colostrum management.

Background

Colostrum is the first milk produced by the dam after calving and contains essential nutritional, growth and immune factors to support the calf's development. Colostrum can be collected from the first 5 milkings post calving, though previous AFBI research has shown that the concentration of immune factors (IgG) diminishes rapidly after birth (Figure 1).

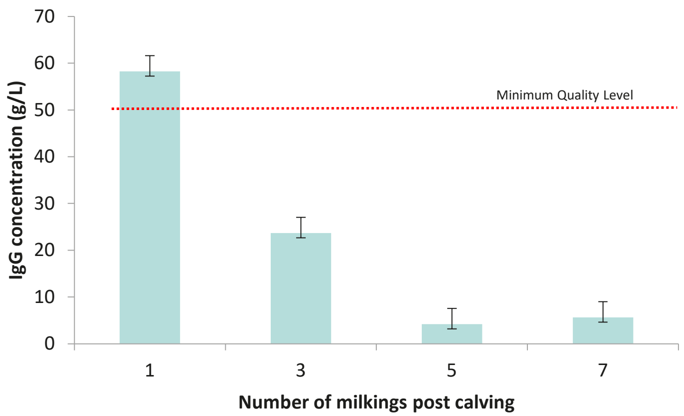


Figure 1. IgG concentration of colostrum based on time collected after calving

The collection and storage of colostrum must be carefully managed to conserve these elements and ensure successful transfer of these properties to the calf. Inadequate handling of colostrum has been shown to increase the bacterial load and reduce the IgG content, contained within this "liquid gold" milk, leaving the newborn susceptible to infection. Industry guidelines indicate a maximum level of 100,000 bacterial colony forming units per ml is required in raw milk to prevent transmission of infection and a lower limit of 50g/L immunoglobulin IgG concentration within colostrum is recommended to prevent the risk of failure of passive transfer (FPT). Different farm and animal management strategies can influence the quality of colostrum produced and therefore AFBI has conducted studies to assess the implications.

Research study details

AFBI collected colostrum samples (n=1,239) from 21 commercial grassland-based dairy farms across Northern Ireland. The samples represented the first milk collected after parturition and were analysed for fat, protein, lactose and IgG content. A subset were also submitted for microbiological testing to determine somatic cell count (SCC) and total viable count (TVC) based on the number of bacterial colony forming units (CFU/ml). Farm level information was collated against these factors by assessing the correlation between herd size, calving season, calving difficulty, breed, parity, pre-calving live weight, body condition score at calving, length of dry cow period, milk yield, immunization regime and dry cow nutrition.

Research findings

The nutritional properties of colostrum collected were highly variable across the participating farms as shown in Table 1. Of greatest concern is the bacterial load determined from the total viable count >100,000 cfu/ml and may represent poor hygiene and handling of colostrum prior to collection. Analysis of the immunoglobulin (IgG) content found 44% of samples contained less than the recommended 50g/L concentration needed to sustain passive transfer of immunity from the dam to the calf. In addition it was found that colostrum samples obtained from cows with a dry period of less than 8 weeks contained significantly lower levels of IgG and fat than samples taken from dams with a dry period of 8-12 weeks. Winter calving season as well as the parity of the dam (Figure 2) was associated with an increase in the IgG and protein of colostrum produced. Dry cow nutrition was not shown to alter the IgG properties of colostrum, whilst prepartum vaccination positively influenced the IgG concentration. The time taken to collect colostrum displayed a significant reduction in colostrum immune and nutritional properties after 12hrs post calving, with samples collected after 6 hours recorded with an IgG of less than 50g/L.

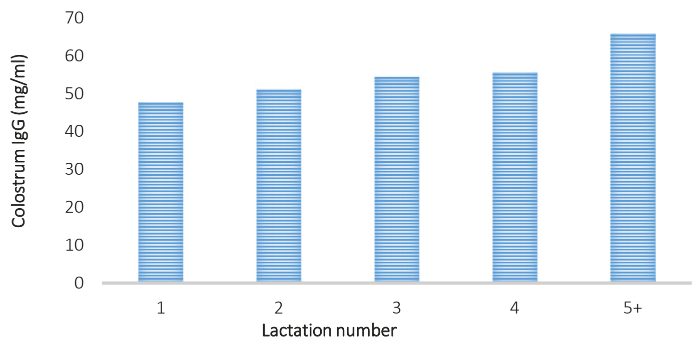


Figure 2. Concentration of IgG by lactation number in colostrum from Northern Ireland dairy farms.

Table 1. Nutritional composition of colostrum sampled across Northern Irish farms

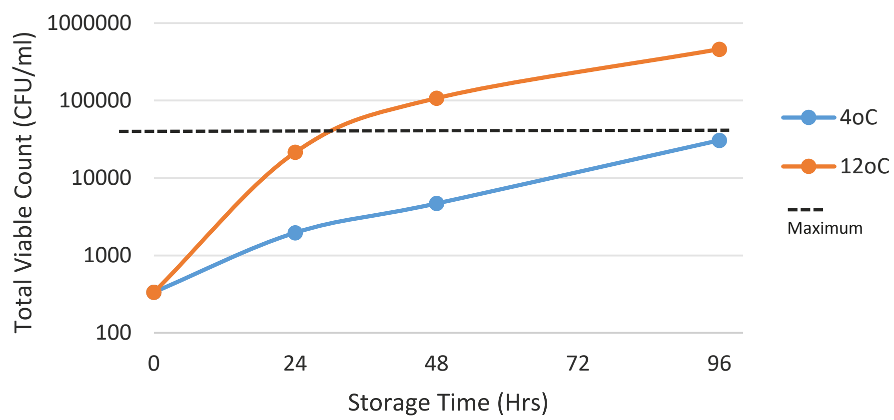
Nutritional quality	Average	Range
Fat (%)	6.4	3.2-16.9
Protein (%)	14.3	8.1-20.0
Lactose (%)	2.7	1.4-4.4
Total Viable Count (x1000 cfu/ml)	2,230	127-14,500
Somatic Cell Count (x1000 cfu/ml)	1,609	903-2,755
IgG (g/L)	55.0	27.3-128.7

Farming guidance

With these variables in mind, it is important to regularly test the quality of the colostrum on your farm to ensure the calf receives sufficient quality colostrum to acquire protective immunity. A simple method to estimate the IgG content on farm is by using a refractometer or colostrometer (Figure 3). Previous research has shown that feeding calves colostrum with a high bacterial load can reduce absorption of IgG leading to FPT. The increase in bacterial load is largely caused by inadequate storage and management of colostrum. Previous AFBI research showed a substantial growth of bacteria in colostrum when stored at different temperatures (Figure 4). As such it is recommended to keep colostrum in a refrigerated environment for up to 48 hours if not being fed directly to the calf, and warm to 38°C in a water bath prior to feeding.

Figure 3. On-farm tests available to determine colostrum quality by A) Digital Refractometer or B) Colostrometer

Figure 4. The growth of bacteria (TVC) found within colostrum stored at different temperatures over a 96 hour period.



CFU - colony forming units

MANAGING COLOSTRUM VARIABILITY

THE IMPORTANCE OF THE FIRST FEED

Ruth Kinkead, Barbara Waters and Steven Morrison

Key messages

- First feed is crucial to calf survival and should be administered quickly, within 6 hours of birth, to enable passive transfer of immunity
- Poor quality colostrum increases likelihood of failure of passive transfer of immunity and consequently increases ill health and mortality risk
- Calves should be fed up to 10% birth weight of colostrum within their first feed to ensure sufficient quantity of nutrients and antibodies are consumed

Background

The protective antibodies within colostrum decline in concentration after calving, therefore it is important to collect colostrum quickly after birth. The calf's ability to absorb these antibodies also diminishes within the first 24 hours of life, so it is crucial to ensure the calf is fed as much of this colostrum within the first day of life. Insufficient consumption of the required quantity or quality of colostrum leads to a reduction in the amount of maternal IgG transferred to the calf, leading to a state known as failure of passive transfer (FPT). The recent All Island Disease Surveillance report (AFBI/DAFM, 2016) indicated that FPT was concurrent in 67% of calf deaths. AFBI is researching into practices to mitigate the risks of calf mortality by ensuring proper colostrum management is in place to provide sufficient immune protection to the calf.

Research study details

AFBI collected background farm management information from 17 commercial dairy farms across Northern Ireland. Each farm submitted colostrum samples collected from 20 dams within their herd immediately after calving, alongside blood samples taken from new-born animals (n=340) within 7days of age. Colostrum samples were analysed for IgG content to determine their quality (>50g/L). The blood samples were used to determine if transfer of passive immunity from dam to calf via colostrum was adequate. The target for IgG concentration in calf serum was to exceed 10 mg/ml in the first 7 days after birth. Further records of illness and mortality were collected from each farm for 12 months after birth to discern the effect of colostrum quality and FPT on the incidence of ill health and fatalities.

Research findings

The IgG content of the colostrum samples obtained from the study revealed 67.3% were of low quality (<50g/L) (Figure 1). Those calves that received low quality colostrum were twice as likely to incur FPT as calves who received higher quality colostrum (>50g/L). FPT was recorded in 33.6% of all calf serum samples collected (Figure 2) with 1/3 of calves with FPT status treated for an ill health incidence, compared to 1/4 of calves with successful immunity transfer (>10mg/ml). Veterinary treatment records indicated reduced incidence of pneumonia (8%) in calves which received higher quality colostrum in contrast to those with FPT (19%). Overall mortality of calves on the study was 5.6%, however, by 3months of age, 6.4% of calves with FPT died whereas only 2.4% of calves with successful passive immunity were dead. These results are in agreement with a previous AFBI study which found that calves who received a greater volume of colostrum at birth (equivalent to 10% birth weight e.g. 4L fed a 40kg calf) achieved a higher IgG status for up to 72 hours after birth (Figure 3) and suffered less incidences of scour than those fed 5% BW volume (2L) of colostrum.

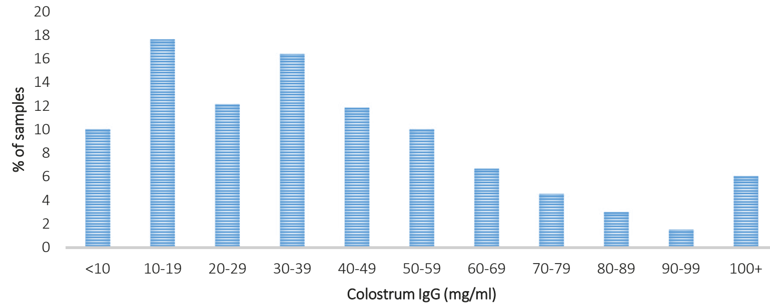


Figure 1 IgG content of colostrum samples obtained from Northern Irish dairy farms

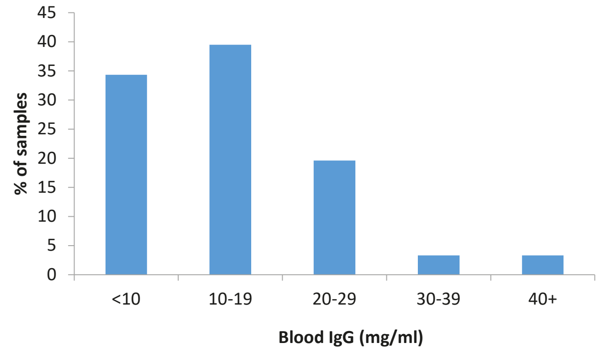


Figure 2 Blood IgG content of calves from Northern Irish dairy farms

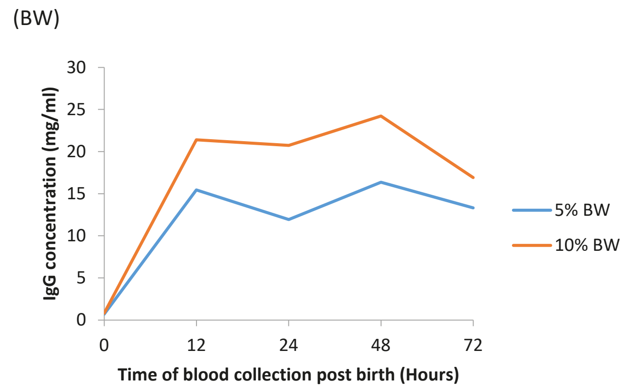


Figure 3 Change in IgG concentration after birth in calves fed colostrum as a % of body weight (BW)

Farming guidance

The provision of high quality colostrum is essential to enable the successful passive transfer of immunity to the calf from its mother. FPT contributes to an increased occurrence of ill health and mortality rate. Therefore an improved management in colostrum provision on farm is necessary not only to reduce these risk but also reduce the costs associated with calf rearing. This will involve feeding adequate volumes of high quality colostrum, ideally at the first feed or as early in a calf's life as possible.

Footnote: AFBI acknowledges funding from DAERA and AgriSearch

IMPORTANCE OF PRE-WEAN NUTRITION

Joshua McDowell, Ruth Kinkead, Alan Gordon and Steven Morrison

Key messages

- Enhanced milk feeding levels show long term benefits on calf growth & performance
- Chopped straw supplemented from 14 days of age encourages concentrate intake for calves on lower milk replacer levels.
- Concentrate intake is encouraged by forage provision during the weaning process for accelerated milk fed calves

Background

Higher daily live weight gain pre-weaning can help achieve key growth targets and has been associated with increased 1st lactation milk production, attributed to enhanced mammary gland development, lean muscle development, and improved feed efficiency. However, feeding accelerated levels of milk replacer (MR) to calves can delay rumen development, and lead to reduced concentrate intake upon weaning. Low concentrate intake before and after weaning can result in the benefits of superior live weight gain from accelerated milk feeding being lost. Previous studies have indicated that restrictive feeding (4 L/day) only supports 20 -30% of a calf's growth potential in the first weeks of life. Other similar studies have shown forage provision can encourage concentrate intake to conventionally milk fed calves. This AFBI investigation explored whether forage provision can encourage concentrate intake for accelerated milk fed calves.

Research study details

The study explored the effects of feeding milk replacer at accelerated compared to conventional quantities as shown in the Table 1. The possibility of encouraging concentrate intake to calves by providing various forage sources at different ages was also investigated. The forage treatments were chopped straw at 14 days, chopped straw at 56 days, grass silage at 56 days of age or no forage provision. The performance and growth of 76 dairy origin calves was assessed from birth until 70 days of age.

Research findings

Live weight (Figure 1.). Results showed calves fed on an accelerated MR feeding regime grow faster (0.8kg/day vs 0.68kg/day) and were approximately 10kg heavier at weaning (70 days of age) than those on the conventional regime. This result has important practical implications as other research shows that higher calf growth rates at 6 weeks of age, and higher concentrate intake at 8 weeks of age can positively influence milk yield.

Concentrate intake (Figure 2). Concentrate intake was reduced for accelerated milk fed calves at the beginning of the rearing period, but increased during weaning step-down. At approx. 8 weeks of age onwards, accelerated calves consumed more concentrate than conventionally milk fed calves. This was due to the gradual weaning process initiated at 42 days of age, and ended at weaning at 70 days of age.

Forage effects (Table 2). Conventional milk fed calves with chopped straw provision from 14 days of age consumed more concentrate than other conventional milk fed calves. Accelerated milk fed calves which had grass silage or chopped straw provided from 56 days of age, consumed higher levels of concentrate upon weaning compared to other accelerated milk fed calves. These results indicate that provision of forage can encourage greater concentrate particularly during milk step down.

Figure 1. Live weight of accelerated versus conventionally milk fed calves

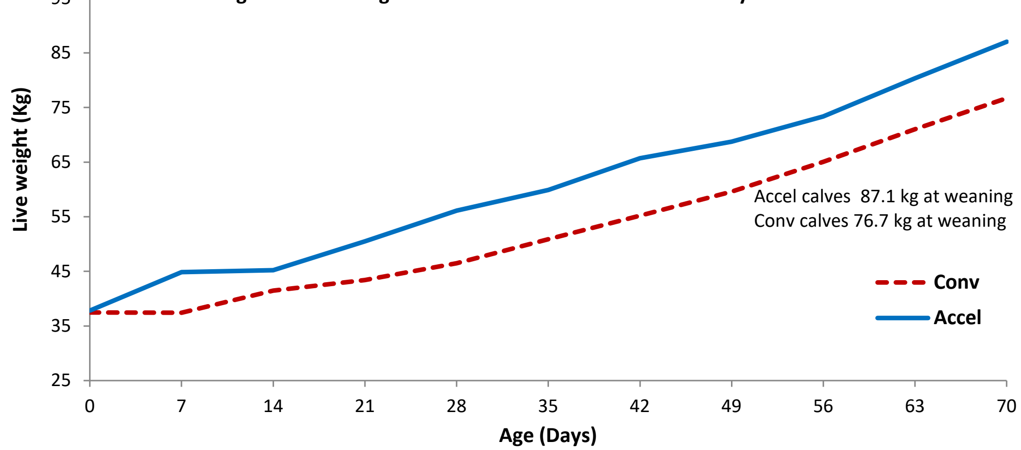
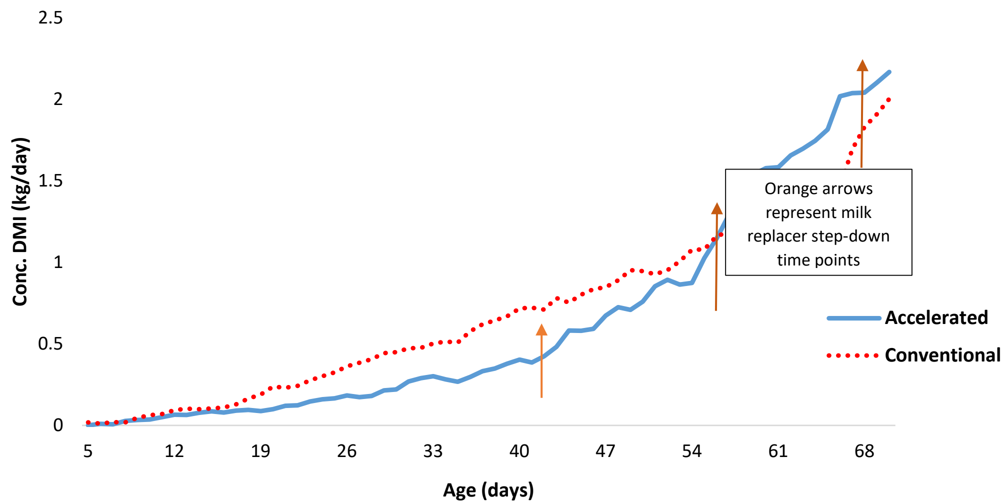


Figure 2. Effects of MR level on concentrate dry matter intake (DMI)



Farming guidance

Results from this calf rearing study show that accelerated milk fed calves had a higher growth rate than conventional milk fed calves, and were able to consume adequate concentrate intake before weaning. This is an important finding as fear of a depressed concentrate intake is a major reason that farmers avoid feeding higher milk quantities. The results from the forage element to the study show that providing accelerated milk fed calves a forage source encourages higher concentrate intake as calves reach weaning. Since previous research has shown that feeding forage fibre to pre-weaned calves enhances rumen development and improves rumen health, the total benefits on farm are expected to be very significant.

Table 1. Milk feeding regime

Milk feeding regime	Accelerated				Conventional	
MR feeding (age days)	5-42	43-56	57-67	68-70	5-67	68-70
MR powder (g/day)	1350	900	450	300	600	300
MR quantity (L/day)	9	6	3	2	4	2
Frequency (meals/day)	3	2	1	2	1	

Table 2. Effects of forage on concentrate level x forage interaction

Milk feeding regime		Intake at Weaning (kg/day)
Conventional	No forage	2.16
	Grass silage 56 days	2.12
	Chopped straw 14 days	2.45
	Chopped straw 56 days	2.07
Accelerated	No forage	2.13
	Grass silage 56 days	2.59
	Chopped straw 14 days	2.31
	Chopped straw 56 days	2.47

HOW MUCH PASTURE TO OFFER THE GRAZING HEIFER

Robert Patterson, Scott Laidlaw, Alan Gordon, Ruth Kinkead and Steven Morrison

Key messages

- Evidence from this study has shown Holstein dairy heifers' can exceed live weight gains of 0.80kg day solely from grazed grass
- Increasing pasture allowance (expressed as herbage DM as a percentage of live weight) from 1.8% to 3.0% improved heifer performance by 0.18kg/day across the season, whilst pasture utilisation dropped 14.2%
- 2.4% pasture allowance is an optimal compromise between animal and pasture performance

Background

Heifer rearing contributes a significant cost to dairying systems, yet can be the most commonly overlooked component. The dairy industry has experienced significant change over recent decades, however heifer rearing practices post-weaning remain relatively unchanged. Heifers achieving target weight is key, as failure adversely affects milk production and can result in reduced fertility. Grazed grass provides a high protein, low fat diet, and remains the cheapest source of high quality feed. Pasture allocation is recognised as a key factor in animal production due to its effect on herbage intake. Pasture allowance will also affect pasture utilisation and the nutritional value of the sward in subsequent rotations. The objective of the study was to investigate the optimum pasture allowance for replacement dairy heifers, to achieve optimal animal and pasture performance.

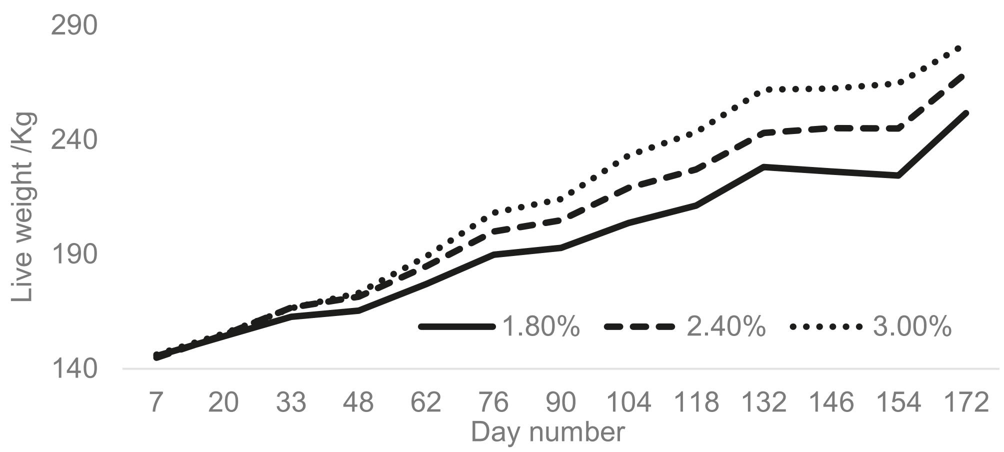
Research study details

The study involved 72 autumn born Holstein heifers, which were assigned to three pasture allowance (PA) treatments at 1.8%, 2.4% and 3.0% of live weight (LW) allowance of grazed grass per day. There were nine groups of eight heifers, which were on average 5 months old and 155Kg at the start of the study. Each group of heifers had a rotation of seven paddocks and paddock area was allocated based on grass availability and target allowances. The study commenced on 6 April 2017 with a 14 day rotation length (2 day paddock residency) until 1 June 2017, with a rotation length of 24.5 days thereafter (3.5 day paddock residency). The study ran for 159 days before finishing prematurely due to deteriorating ground conditions. Heifer live weight and body condition score were recorded on a fortnightly basis. Compressed sward heights were measured with a rising plate meter and recorded on animal entry and exit to each paddock.

Research findings

The average live weight gain of the heifers on the 1.8%, 2.4% and 3.0% treatments across the season was 0.64, 0.75 and 0.82kg/day, respectively. There was a greater range in weights recorded among the animals on the highest pasture allowance. Figure 1 shows a reduction in weight gain from day 132 to 154, due to a period of unsettled weather with a high rainfall. Animals offered the highest and medium pasture allowances, maintained their weight, however those given the lowest pasture allowance lost weight. Pasture utilisation was greater in the lowest pasture allowance (Table 1). It was also expected that as pasture allowance increased, pasture production and pasture quality would decrease, however no significant difference was observed in either pasture production or quality across the three treatments.

Figure 1 Effect of pasture allowance on heifer live weight growth across the season



Farming guidance

Allocating a higher allowance of grass to heifers can improve performance while not affecting the amount or quality of the grass grown. Increasing pasture allowance from 1.8% to 3.0% improved live weight gain by 0.18kg/day across the season, however pasture utilisation decreased by 14.2%. Therefore, the practical conclusion is that a pasture allowance in the region of 2.4% of herbage Dm perkg of live weight, is the optimal compromise between animal and pasture performance.

Figure 1. Drone image of paddocks used to set different pasture allowances for grazing heifers

Table 1. Effect of pasture allowance on heifer live weight growth across the season

Treatment	1.8% LW	2.4% LW	3.0% LW	Responses
Utilisation/ %	81.5	72.4	67.3	Highly significant differences
Av. Pre grazing cover/kgDM/ha	3125	3359	3510	No significant differences
Pasture Production/ T DM	11.17	11.74	12.22	No significant differences

Treatments were 1.8%, 2.4% and 3.0% of the live weight (LW) allowance of grazed grass per day

Footnote: AFBI acknowledges funding from DAERA, AgriSearch and AHDB

ROTATIONAL GRAZING OPTIONS FOR HEIFERS

Robert Patterson, Scott Laidlaw, Alan Gordon, Ruth Kinkead and Steven Morrison

Key messages

- Rotational grazing systems using the same quantity of land for dairy calves enabled 455kg DM/ha to be ensiled compared to set stocking.
- Animal performance with zero concentrate supplementation during the grazing season was 0.64kg/day whilst rotational grazed animals achieved an extra 0.04-0.16kg/day
- Periods of poor weather and difficult grazing conditions dramatically reduced calf growth rates. This highlights the important role of monitoring heifer growth during the grazing season.
- Future research will examine the role of strategic supplementation in periods of poor weather/limited grass availability to ensure achievement of target growth but maximising heifer growth from grazed grass.

Background

Grazed grass is the cheapest feed source on a farm and a high level of utilisation has the potential to dramatically reduce feed costs and improve animal performance. Proper utilisation requires letting animals graze at the right time, to the right height, and having the right amount of stock per area. Grass utilisation in a given grazing system can be increased by monitoring sward height and cover on a regular basis. Set stocking, in which animals have unrestricted access over a wide area requires low management input, low capital costs and can work well if sward height is managed properly. However, set stocking is generally associated with lower forage yields, uneven manure distribution, poor grass utilisation and can be difficult to maintain grass quality and sward height. Rotational grazing requires closer monitoring of forage supply and investment in fencing but can result in higher productivity since animals are moved around a number of small paddocks after a certain number of days based on sward height and cover. This allows paddocks time to rest and recover, and also makes it possible to extend the grazing season period. AFBI designed a study to quantify the impact of different grazing management strategies on youngstock performance and grass productivity in terms of herbage quality and utilisation.

Research study details

90 Holstein heifers aged 3-7 months were split into similar size by age groups and assigned to one of three grazing systems:

(1) continual grazing system, with animals remaining for the duration of the grazing season

(2) 6-day rotation system in which animals were rotated through 6 paddocks every 6 days

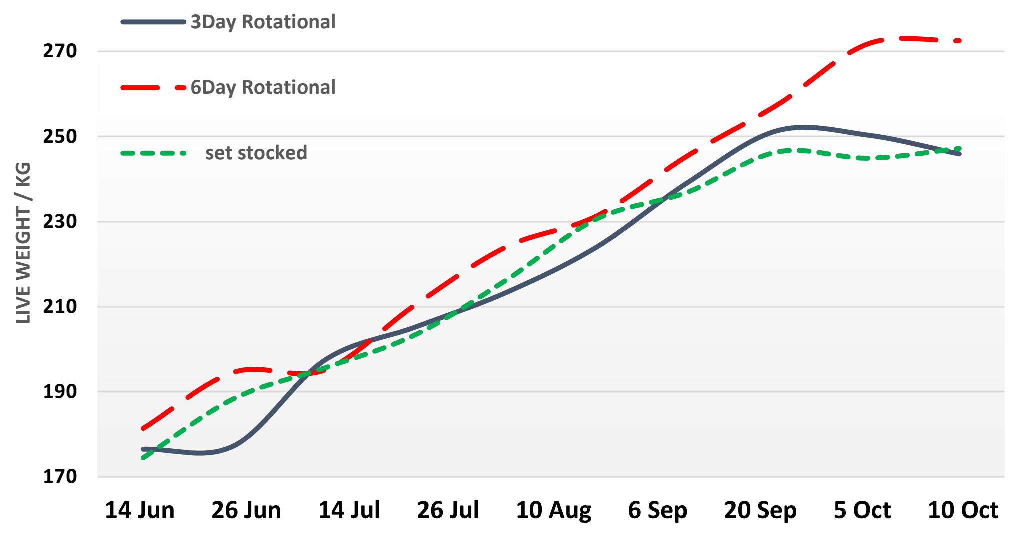
(3) 3-day rotation system, with animals rotated through 12 different paddocks every 3 days.

Target pre and post grazing sward heights were set at 2500 and 1600kg DM/ha respectively. Sward height was measured each week and upon entry and exit of animals from the paddock. Heifers were weighed and body condition scored every fortnight. Grass clippings were taken on a weekly basis for analysis of quality parameters (dry matter, crude protein, fibre content etc.). Soil Moisture and weather recordings were taken on a weekly basis. The study ran for 113 grazing days (17th June to 10th October) and all areas received the same fertilizer treatment.

Research findings

The final average live weight of heifers at 8-13months of age on continuous grazing was 247kg; 3 day rotation was 246kg; on 6 day rotation was 273kg as shown in Figure 1. A period of adverse weather conditions resulted in a slight decrease in the average daily live weight gain achieved during the last week of the grazing period. This caused a slight reduction in the weight gain of 3 day rotational (0.68kg/day) and continuous stocked (0.64kg/day) animals compared to 6 day rotational stocked heifers which achieved 0.80kg/day live weight. AFBI is currently investigating why animals rotated every 3 days had a lower performance than 6 day rotation. As part of this, it may prove that there is a need for strategic concentrate supplementation during poor weather to alleviate such effects. Surplus grass was ensiled, with a total of 455kg DM/ha removed from the 3 day rotational grazing system and 272kg DM/ha from the 6 day rotation. Whilst the nutritional quality of the sward parameters did vary across the season, there was no significant effect of grazing treatment on the amount of herbage grown.

Figure 1. Effect of grazing system on heifer live weight growth across the season



Farming guidance

Rotational grazing systems permitted surplus grass to be ensiled whilst still achieving 0.68kg – 0.80kg/day growth, which outperformed the set stocked system. Therefore, with land often a limiting constraint on local dairy farms, rotation systems enable farmers to achieve efficient pasture utilisation while achieving high average daily live weight gains in heifers at grass.

Footnote: AFBI acknowledges funding from DAERA, AgriSearch and AHDB

SOIL STRUCTURE

AN INDICATOR OF POTENTIAL PRODUCTIVITY

Alex Higgins

Key messages

- A compacted soil can reduce grass yields by 25%, decrease fertiliser use efficiency, and increase surface runoff, soil erosion and gaseous emissions of nitrous oxide and ammonia.
- Signs of compaction include surface ponding, reduced yields and a cloddy grey appearance to the soil.
- Mild compaction can be removed by slitting of the soil surface; sub-soiling may be required where compaction is severe.

Background

Soil structure is critically important in determining the agricultural productivity of any soil. Factors such as water holding capacity, water movement, aeration and heat transfer are all strongly influenced by soil structure. For any given soil type, all other factors being equal, the presence of well developed, open soil structure will always lead to better crop growth than if a soil is highly consolidated.

What is soil structure?

Over time all topsoil particles will tend to bind together into units of various sizes. The size and degree of development of these units will be controlled by the physical composition of the soil (percentage distribution of sand, silt and clay particles), the organic content of the soil, the nutrient status of the soil and the land use that the soil undergoes. Structural units form into a number of specific recognizable geometrical shapes; the four most common are illustrated in Figure 1.

Figure1. Photographs of soils showing common structural characteristics

Assessing soil structure

A visual examination of the existing soil structure within a field is a quick way of estimating the health and potential productivity of your soil. Although this can be carried out at any time of the year, the structural units are most easily identified when the soil is moist. Normally at least 3 inspection pits are required to get a representative picture for a field (more in a large field), or where there is a range of soil types or soil conditions. A square block, 40cm x 40cm x depth of the topsoil is removed with a spade and examined.

The first thing to look for in the excavated block is the general soil colour. Well aerated topsoil will have a strong brown colour; poorer aeration will result in more grey colours or rusty discoloration being present. Next, note the presence of voids (either fissures between the soil structural units or pores within the units). Soil with good, well developed structure will have a high percentage of voids, allowing good drainage, aeration, root growth and general biological activity. The final step is to look at the structural units, by gently teasing the soil apart by hand. In Northern Ireland, the structure in the topsoil will fall within the following 4 classes:

- Granular: Small spherical units, highly porous, root development throughout. Mostly found on freely draining soils or under long term pasture.
- Sub-angular: Blocks with curved or rounded sides, porous, root development throughout. Found widely throughout all types of soil.
- Angular: Blocks with flat sides, reduced porosity, root development around the blocks or concentrated in large pores. This can develop in heavy, imperfectly drained soils.
- Platy: Blocks with horizontal, flat sides, root development can be very restricted. This can develop in any soil as a result of compaction.

Soil Compaction

All productive soils require a degree of compaction to ensure good contact between plant roots and soils to maximise uptake of water and nutrients. 'Soil compaction' occurs when soil particles are consolidated beyond an optimum level as a result of an applied force. As a consequence, soil bulk density is increased making root penetration difficult, and soil pore volume is decreased, reducing soil aeration, water infiltration and natural drainage. These changes can reduce grass yield by up to 25%, and also decrease fertiliser efficiency and increase surface runoff, soil erosion and gaseous emissions of nitrous oxide and ammonia.

Farming guidance

In Northern Ireland soil compaction is mainly due to vehicle traffic, animal treading, and cultivation operations all of which can damage the soil structure. Virtually all soils are vulnerable to some form of soil compaction under the right combination of circumstances. The most important factor to be aware of on farm is of course soil moisture; the wetter a soil the lower its capacity to withstand compression. There are two main visual indicators of soil compaction: (1) the appearance of new wet spots in fields after rainfall and (2) variations in grass growth across fields, often in zones of heavy trafficking. However, the most reliable method of identifying soil compaction is to open inspection pits and examine the soil structure.

POTASH MISMANAGEMENT

BAD FOR GRASS AND DAIRY COW PRODUCTION

John Bailey and Susanne Higgins

Key Messages

- Potash deficiency can result in DM yield losses of up to 30%
- Large amounts of potash are needed to make efficient use of nitrogen
- Excessive use of potash, however, can trigger animal health problems

Background

On average across Northern Ireland, about 40% of farmed grassland soils are low or deficient in potash (K index 0 and 1), and about 20% are over-supplied with this nutrient (K index 3-5). Both situations are undesirable. Recent farm surveys undertaken by AFBI have revealed appreciable proportions of potash-deficient soils on individual dairy farms largely as a result of a failure to recycle manure to land used for silage cropping. The surveys also revealed that 15 to 20% of 1st and 2nd cut silage swards were deficient in potash and suffering dry matter (DM) yield losses of up to 30%. That being said, on the more intensive dairy farms, potash overuse is also a problem, with more than 30% of farmland at K index 4 and above (Figure 1) and thus with the potential to exacerbate animal health problems.

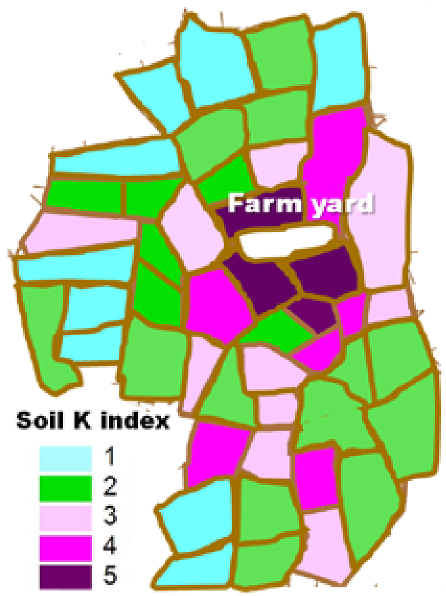


Figure 1. Soil K indices on a typical intensive dairy farm
Figure 2. Grazed sward and Silage sward

Knowledge of potash levels in soil is essential

It is impossible and irresponsible to guess the amount of manure and fertiliser potash that grazed or cut swards require without doing regular soil analysis about every 4 years. Soil analysis provides a useful measure of the amount of potash available to grass and forage crops. In its absence, manure is often applied to fields closest to farmyards, simply for convenience sake, thereby causing an excessive build-up of potash in these soils (K index 4-5). In contrast, fields further away receive little or no manure and become potash-depleted (K index 1) (Figure 1). Without soil analysis, potash deficiency is not easily identified in grassland and can be thought of as a 'hidden hunger', since yield losses can occur without any recognisable visual symptoms. However, under more severe K deficiency conditions the edges and tips of older leaves develop a characteristic paper-brown coloration (Figure 2).

Grass requires large amounts of potash to make efficient use of nitrogen

Fertiliser nitrogen (N) cannot be utilised efficiently if potash supplies are inadequate. When potash inputs to grassland are insufficient, uptake and utilisation of fertiliser nitrate-N will be restricted. Both nutrients need to be simultaneously available to swards in large amounts if full yield potential is to be achieved. If nitrate is not taken up but remains in the soil, there is a risk that it will be leached into waterways and give rise to algal blooms, or else be converted into the potent greenhouse gas nitrous oxide (N_2O).

Potash overuse can be detrimental to the health of dairy cattle

Excessive use of potash (as fertilisers or manure) on pastures has been associated with grass tetany (hypomagnesaemia) in dairy cattle. This condition develops when insufficient magnesium (Mg) is absorbed from the diet. Luxury uptake of potash by swards on potash-enriched soils can reduce Mg uptake. Excessive concentrations of potash in grass and forage also reduces the ability of cattle to absorb Mg. Lactating cows are particularly susceptible to this condition in early spring.

Milk fever (Hypocalcaemia) is also linked to excessive concentrations of potash in dairy cow diets. Dry cows fed forages containing moderate to high levels of potash can be susceptible to milk fever following calving, since the previous excess intake of dietary potash pre-calving hinders their ability to absorb Mg, which in turn is needed by the parathyroid gland to control blood calcium levels. Excessive levels of dietary potash can also induce metabolic alkalosis in dry cows, thereby reducing their ability to maintain blood calcium levels in early lactation. 'Luxury' uptake of potash by forages largely results because of potash being applied to grassland without knowledge of the soil potash status. Applying potash on the basis of soil test information will produce forages with lower (yet adequate) concentrations of potash thus reducing the risk of tetany and milk fever in cattle.

Farming guidance

Let the soil feed the grass crop and add fertiliser and manures to feed the soil

Potash reserves in soil are more effective at supplying plants than fresh fertiliser applications. Potash depleted soils (K index 0 and 1) will often fail to produce the same yields as fertile soils even if much higher rates of potash are applied. So farmers should seek to maintain adequate reserves of potash in their soils by using fertilisers and manures to replace what is removed by cutting or grazing. For soils with low potash reserves (K index 2 or less), extra fertiliser potash should be applied in the autumn to restore fertility to target levels. In contrast, where soils are overly enriched with potash (K index 4-5), farmers can and should lower or omit fertiliser usage (and manure application) to reduce the risk of grass tetany and milk fever in cattle.

SULPHUR IS ESSENTIAL TO ENSURE HIGH YIELDS OF GOOD QUALITY GRASS

John Bailey and Susanne Higgins

Key messages

- More than 20% of silage and grazed swards are sulphur deficient in SPRING and losing up to 30% of DM production
- Sulphur requirements cannot be met by slurry alone
- Sulphur-containing fertiliser should be applied routinely in spring to ALL silage and grazed swards - even to those where slurry has been applied
- The SO^3 will cost about an extra £5/ha/cut but will prevent yield losses worth up to £90/ha/cut

Background

Due of declining inputs of sulphur (S) from the atmosphere and a 50-fold reduction in the amount applied in fertilisers today compared with the 1950's and 1960's, soil S reserves are now insufficient to support grass production on large areas of farmland across Northern Ireland (NI), but particularly during the early part of the growing season. Out of 67 dairy farms in NI surveyed between 2004 and 2006, 49 had swards testing as S deficient at 1st cut (April/May) in at least one of these years (Figure 1). While sands, shallow soils and sandy loams with low organic matter levels are generally most prone to S deficiency, this deficiency is now being found on all soil types, including heavier textured clays and clay loams (Figure 1).

Figure 1. 49 dairy farms with S-deficient swards in spring

Figure 2. Sulphur-deficient sward

Sulphur deficiency impairs grass yield and feeding quality

AFBI research has shown that dry matter (DM) yield losses of up to 30% are now occurring at 1st cut or 1st grazing as a result of S-deficiency, whereas in the 1980s and 1990s S deficiency was primarily a 2nd or 3rd cut phenomenon. Highly deficient swards appear pale yellow-green in colour (Figure 2), but up to 20% of DM yield may be lost without any recognizable visible symptoms in the herbage. Not only does S-deficiency significantly hamper grass DM production, it also reduces its feeding value. Sulphur has a vital role in protein production, being a core element in two of the essential amino acids that make up the building blocks of protein. Under S-deficient conditions, the true protein content of grass declines, and this not only reduces its value as a protein source for ruminants, it also hampers its ability to accumulate sugars and thus impairs its fermentation quality when ensiled. A shortage of S in herbage can also reduce the digestibility of forages. Rumen microbes require both nitrogen and S to produce their own protein, and a shortage of S will hinder this process thereby curtailing important metabolic functions.

Don't rely on slurry to meet the sulphur requirements of forage crops

The apparent underuse of S fertiliser on grassland may be due in part to the assumption that slurry applications provide enough readily available sulphate-S to meet the needs of silage crops. In theory, a 33 m^3/ha (3000 gallons/acre) application of 6% DM cattle slurry to silage swards will supply 26kg SO^3/ha, which is close to the 25–40kg SO^3/ha required for one crop of silage. But the availability of slurry-S to crops is highly variable and often low, largely because variable amounts of sulphate are converted into sulphide (a potential plant toxin) under anaerobic slurry storage conditions. Consequently, in the latest edition of the RB209 Fertiliser Manual, it is recommended that S inputs from manures should only be regarded as contributing to the maintenance of soil S reserves and not to the needs of subsequent silage crops.

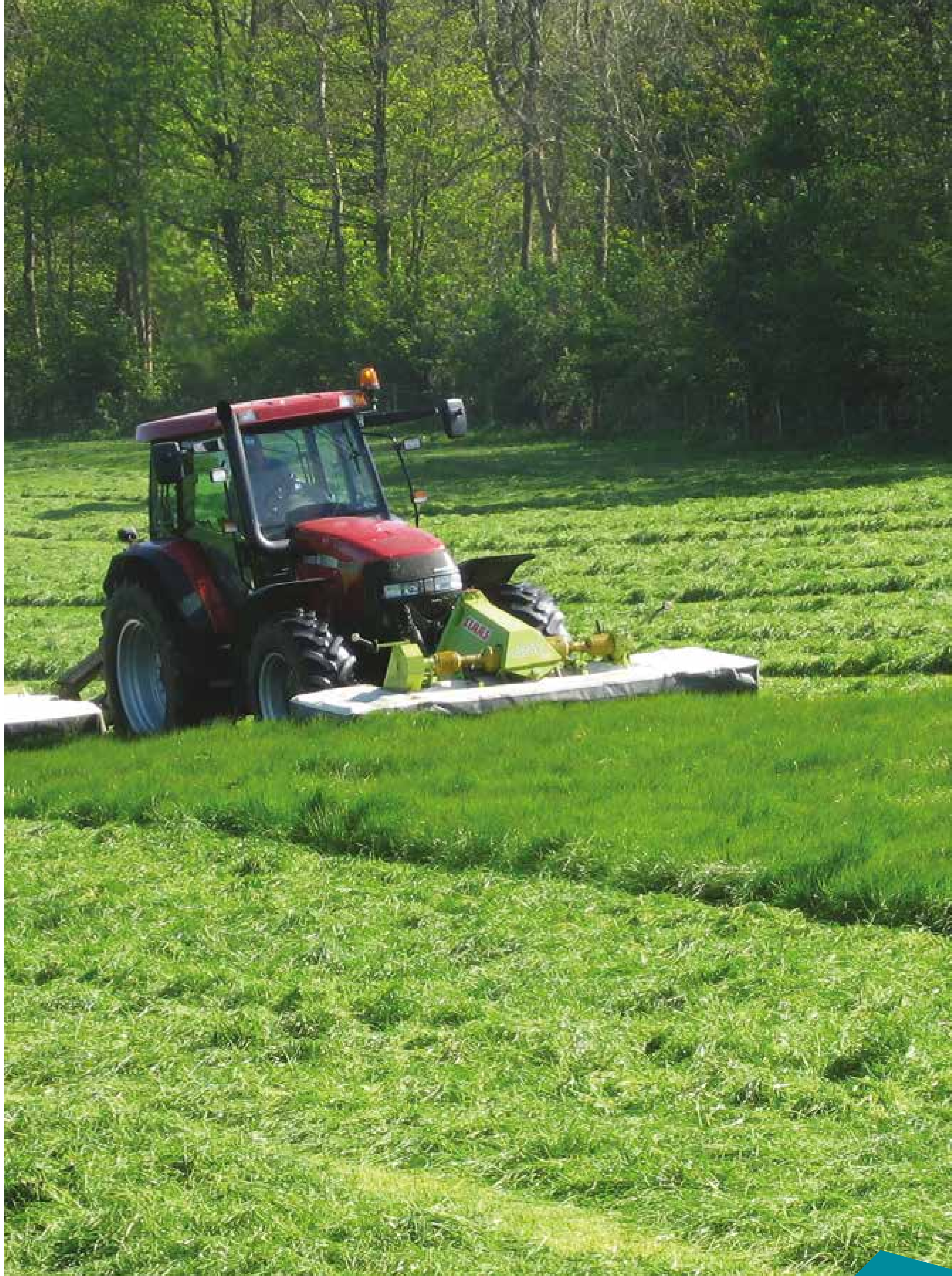
The soil sulphur test can be unreliable

For highly 'mobile' soil nutrients such as sulphur, the winter/spring soil test only indicates the amount of nutrient available in the soil at the time of testing. If a prolonged period of wet weather occurs following soil testing, much of the sulphur may be washed out of the soil and into land drainage water. In such circumstances, herbage analysis may be used as a 'back-up' to diagnose sward S status early in the season (mid-April) and provide an early warning of S insufficiency which may be corrected in the April top-dressing or when applying fertiliser for subsequent silage crops. In fields where S-deficiency is suspected, i.e. where the soil test shows that S reserves are very low, S-containing fertilisers should be applied at 40kg/ha SO^3 for 1st, 2nd and 3rd cut silage crops, and during mid-season under grazing.

Farming guidance

Apply sulphur-containing fertilisers routinely to all grassland

Given that S-deficiency can occur in spring on all soil types, regardless of the soil S test result, and regardless of whether or not slurry has been applied, S-containing fertilisers ought to be applied routinely to all grassland at the start of the season. It is recommended that 25-40kg SO^{3}/ha should be applied as chemical fertiliser to ALL silage and grazed swards in SPRING - even to those where slurry has been applied. This moderate dressing of S, which costs about £4-5/ha per cut or rotation, is unlikely to be detrimental to livestock, and has the potential to prevent yield losses worth up to £90/ha/cut. Sulphur-containing fertilisers should also be applied routinely for 2nd and 3rd cut silage crops on farmland that has received little or no slurry or where soils are shallow or sandy in texture.



NEW PHOSPHATE MANAGEMENT PROTOCOLS TO MAXIMISE GRASS PRODUCTION

John Bailey and Susanne Higgins

Key messages

- Over-use of phosphate (P_2O_5) fertiliser should be avoided to reduce the risk of P loss to water
- Under-use of (P_2O_5) can hamper grass production
- To optimise grass production, the P index 2 range for grassland soils has been split into a new target index range of 2+ (16-20 mg P/l), and a new P-building range of 2- (21-25 mg P/l), with higher (P_2O_5) recommendations in the 2- range

Background

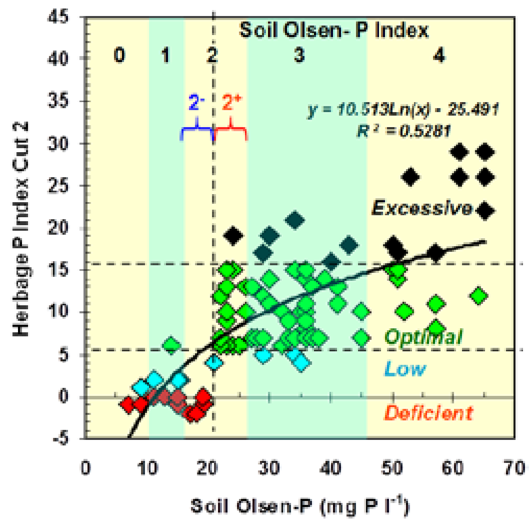
Over the past 40 years, phosphate (P_2O_5) inputs to grassland have often exceeded sward requirement and as a result phosphorus (P) deficiency has ceased to be the threat that it was in the pre and post-war era. In the last 10 years, though, with the dramatic decline in fertiliser P_2O_5 usage on grassland, there is once again a risk that Phosphorus deficiency could become a problem unless care is taken that swards receive adequate supplies of P_2O_5 as fertiliser and manure. Farmers in Northern Ireland (NI) have been particularly concerned that P_2O_5 recommendations for grassland in the lower half of the soil P index 2 range (10-15 mg P/l) may be insufficient to maintain high yields of quality grass and forage.

Strategic research confirms the need for new P_2O_5 recommendations

Monitoring of soil and sward Phosphorus levels (Figure 1) in silage and grazing fields undertaken by AFBI on a province-wide network of dairy farms over several growing seasons, revealed that during mid and late-season, both cut and grazed swards became Phosphorus deficient when RB209 recommended rates of P_2O_5 were applied to soils at the lower end of the target P index 2 range (10-15 mg P/l) (Figure 2). There appeared to be justification therefore for splitting the index 2 range into a 2- (16-20 mg P/l) P-building range, and a new 2+ (21-25 mg P/l) target range, with higher rates of P_2O_5 recommended for grassland in the 2- range.

Figure 1. Collecting soil samples for P analyses and grass samples for P determinations

Figure 2. Herbage P indices for 2nd cut silage swards on soils with different levels of Olsen-P revealing P deficiency problems in grass when Olsen-P is at the lower end of the index 2 range (2-) and RB209 rates of P_2O_5 are applied



New phosphate recommendations for grassland soils at P index 2-

On the basis of the above research by AFBI, revised Phosphorus Regulations (2015) were produced, containing new P_2O_5 recommendations for grassland crops in the P index 2- range, as shown in Table 1. These new recommendations should prevent P deficiency occurring during the growing season and thereby maximise sward productivity.

Table 1. New P_2O_5 recommendations for grass establishment, 1st cut silage, hay and grazed swards on soils at P index 2 –

	Soil Olsen P Index					
	0	1	2-	2+	3	4
	(kg P_2O_5/ha)					
Grass establishment	120	80	65	50	30	0
1st Cut Silage	100	70	55	40	20	0
Hay	80	55	43	30	0	0
Grazing	80	50	35	20	0	0

Revised manure P_2O_5 availabilities to optimise P management

When the Phosphorus Regulations were first introduced in NI in 2006, the European Commission insisted that the (crop) availability of P_2O_5 in organic manures should be artificially fixed at 100% - i.e. double what it really is! However, because of this, farmers in NI may not be able to apply sufficient crop-available P_2O_5 to meet crop requirements on land of low P_2O_5 status (P index 0 and 1). For example, if cattle slurry is used to supply about 70% of the RB209 P_2O_5 recommendation for silage crops on index 1 soils and the remainder is supplied as chemical fertiliser, only 63% (30kg P_2O_5/ha) of the recommended crop-available P_2O_5 input (48kg P_2O_5/ha) will actually have been provided, as outlined below:

- P_2O_5 recommendation for 3-cuts of silage on P index 1 soils = 48kg P_2O_5/ha
- 66 m^3/ha cattle slurry supplies 36kg total P_2O_5/ha or 18kg available P_2O_5/ha
- Amount of chemical P_2O_5 permitted is thus 48 - 36kg P_2O_5/ha = 12kg P_2O_5/ha
- Total available P_2O_5 applied is therefore only 12 + 18kg P_2O_5/ha = 30kg P_2O_5/ha

Farming guidance

Farmers now need to be aware that the AFBI science backed case was made to the European Commission that P_2O_5 availability should be set at 50% for liquid manures and 60% for solid manures, when applied to soils of low P status, i.e. P index 0 and 1, was accepted! The Phosphorus Regulations (2015) have been revised accordingly. So in the example above, chemical P_2O_5 at 30kg/ha may now be applied. Farmers can now fully meet crop P_2O_5 requirements on low P soils, and what's more, have better opportunity to redistribute manure away from high P soils and onto P impoverished land.

PERENNIAL RYEGRASS BREEDING AT AFBI LOUGHGALL

David Johnston and Gillian Young

Key messages

- Many of the grass varieties used on Northern Irish farms are bred by AFBI at Loughgall
- The breeding priorities in the AFBI grass breeding programme are to improve total grass yield, early spring growth, disease resistance, herbage quality and winter hardiness
- Palatability is an important herbage quality, and so all new AFBI varieties are tested on local farms under grazing.
- Breeding continues to focus on grass quality, including reducing mid-season heading, digital imaging for disease assessment and adopting genetic marker technology.

Background

Northern Ireland dairy farmers have a distinct advantage over most of their European counterparts, with their ability to grow large quantities of quality grass. Although many farms make maximum use of grass for grazing and silage, grass remains under-exploited in terms of production and utilisation, and the production of milk from forage has steadily declined over the last ten years. Research work at AFBI Hillsborough has shown that for each 1000 litre increase in milk from forage, profit per cow increases by £120.

Maximising grassland output per hectare under Northern Ireland conditions is largely dependent upon well managed perennial ryegrass swards. However, NI Farm Census statistics show that the area of grassland under five years old has steadily declined in recent years. It is well proven that old 'worn out' swards show a poor response to fertiliser, compared to a new reseed, producing lower yields of forage of inferior nutritional quality.

A key aspect in improving production is to reseed old swards with improved varieties. Advances in grass breeding research means that new varieties which are now on the market show a significant improvement in yield and nutritional quality and can contribute significantly to enhanced dairy farm profitability. For example today's varieties will produce up to 10% more yield per ha than varieties used twenty years ago.

AFBI bred varieties

Many of the grass varieties which are used on farms throughout Northern Ireland have been bred by AFBI at Loughgall in Co Armagh. The breeding programme has been in existence since 1952 and for the last twenty five years has been jointly funded by DAERA and the Dutch seed company Barenbrug. Well known varieties, including Navan, Spelga, Tyrella and Portstewart, have contributed significantly to pasture production on farms throughout the UK, Republic of Ireland, and further afield.

Breeding objectives

When the programme was initially established at Loughgall, the main objective was to produce persistent high yielding varieties for grazing and conservation. At that time, grass seed was an important crop on many farms in Northern Ireland and the seed producing ability of a new variety was therefore an important breeding objective. However, much has changed during the last 65 years, including the disappearance of grass seed production from local farms. Nowadays, the breeding focus is on total yield under silage and grazing, early spring growth, disease resistance, herbage quality and winter hardiness.

Disease resistance

Foliar diseases are becoming an increasing problem on farms throughout Ireland and have a detrimental effect upon both sward production and palatability. I n higher rainfall areas, such as Fermanagh and West Tyrone, leaf-spot poses a serious threat, while in drier, eastern parts of the country, crown rust, which is distinguished by orange pustules, is increasingly evident. In England, disease resistance is already an important characteristic when selecting varieties for a re-seed and this is likely to become a big issue on Northern Ireland farms in the near future.

In order to breed disease resistant varieties, AFBI evaluates all new breeding material with Barenbrug in France and the Netherlands, where foliar diseases are widespread. The results from these trials are combined with data from Loughgall, to identify high yielding, disease resistant plants which can then be used in the crossing programme. This approach has allowed the breeding of varieties such as Rosetta and Dromara, which have both high rust resistance and good yield.

Herbage quality

Considerable effort has been invested by AFBI into breeding for improved digestibility at every stage in the breeding programme, as highly digestible forage produces more meat and milk. Selecting grasses which produce fewer seed heads in mid-season, has been a key aspect of this, supported by laboratory analysis. An important aspect of herbage quality is palatability, as this is the main parameter driving animal intake. Consequently all new AFBI varieties are trialled on local farms, where their performance under grazing can be monitored. Work carried out by Teagasc in the Republic has shown that several AFBI varieties, including Dunluce and Drumbo, are particularly well grazed by dairy cows throughout the season.

Hybrids

Hybrid ryegrasses are produced by crossing an Italian ryegrass with a perennial. Some hybrids express the characteristics of the Italian parent very strongly, producing very high yields of up to 20 tonnes per hectare. Other hybrids, such as Foyle and Drumlin, are very persistent, consistently producing high yields over many years and showing rapid recovery after cutting. These varieties are particularly well suited to local farms which are using zero-grazing or are supplying an anaerobic digester.

The Future

New research on the more fundamental aspects of plant breeding is being undertaken by AFBI, through funding from DAERA. This includes the use of digital imaging for disease assessment and the possible adoption of molecular techniques for Genetic Marker Technology. Continued investment in the programme, strongly enhanced by the connection with the commercial partner, will ensure a steady supply of new grasses and clovers which can meet the ever changing demands of local dairy farms.

Perennial Ryegrass Variety portfolio

An extensive portfolio of AFBI-bred varieties is presently available for use in NI, with further varieties being multiplied for commercial release.

Intermediates

- Moira (Diploid)
  Excellent spring growth with good quality
- Fintona (Tetraploid)
  Exceptionally high production with good quality and persistency
- Caledon (Tetraploid)
  High yields of high quality forage, particularly under silage management
- Seagoe (Tetraploid)
  Produces very high 2-cut silage yields and high silage yields with excellent spring growth
- Glenariff (Diploid)
  Excellent grazing variety producing dense, leafy swards

Lates

- Drumbo (Diploid)
  Produces leafy, dense swards with good summer and autumn growth
- Dundrum (Diploid)
  Very high 2-cut silage yields with good digestibility. Produces high quality grazing.
- Glenarm (Diploid)
  Excellent production of high quality grass for silage and grazing.
- Ballintoy (Tetraploid)
  A new variety for 2018 which will set a very high standard for total yield and spring growth.

A view of the perennial ryegrass breeding programme at AFBI, Loughgall

David Johnston (AFBI) with one of the newest AFBI varieties: Ballintoy

IMPLICATIONS OF RYEGRASS SEED MIXTURES ON SWARD PRODUCTIVITY

David Patterson

Key messages

- Perennial ryegrass remains the dominant component of seed mixtures but different combinations of ploidy and maturity change how the sward will perform
- Mixtures with a wide spread of ryegrass heading dates flattens yield distribution across the season and between years and suits grazing systems
- Mixtures with a narrow spread of ryegrass heading dates helps optimise the yield-quality balance for silage production
- Varieties will compete and change in proportion after sowing, requiring mixture design to offset changes and give the required composition in the established sward.

Background

Commercial grass seed mixtures typically have combinations of diploid and tetraploid perennial ryegrass varieties with each component variety having a specific heading date. The trend over recent years has been to have fewer varieties within mixtures and a higher proportion of tetraploid varieties used in grazing swards in particular. The design of mixtures involves combining varieties with different attributes to create a sward with a production capability greater than any individual variety. One of the most important factors in compiling mixtures is deciding how wide or narrow a spread in heading dates to build into the design. AFBI research has quantified the extent to which diploid to tetraploid ratio and heading date range impacts on sward performance.

Research findings

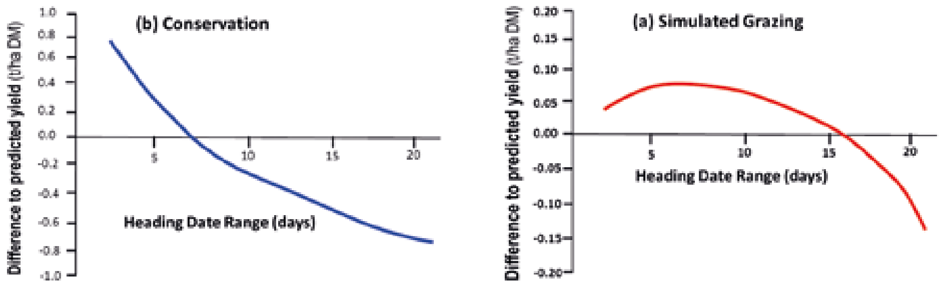
In a grazing trial of different perennial ryegrass varieties joint AFBI-Teagasc research in 2014 found that tetraploid varieties were grazed off to a lower residual height than diploids and they had higher digestibility. They concluded that tetraploids were being better utilised than diploid varieties, albeit the tetraploids had lower overall dry matter content.

An earlier AFBI study, investigated the dry matter yield performance of mixtures relative to their individual variety components, by tracking their proportions within the sward using a genetic test to measure each component. The tetraploid components within a range of diploid:tetraploid mixtures, was always found to be the more aggressive than the diploid varieties. This was not related to variety heading date but due to the resultant canopy structure of the tetraploid swards. Tetraploids have longer wider leaves than diploids, especially in comparison with dense growing diploids, which gives them a spatial advantage in the sward canopy. This means that tetraploids tend to increase in proportion from their sowing ratio, mostly within the first full growing season. This also highlighted that the utilisation of any variety under grazing is a vital assessment to build into any decisions on what varieties perform best on farm.

A third more recent review study investigated the impact of differences in variety maturity (heading date) using commercial seed mixtures managed under simulated grazing and conservation cutting regimes.

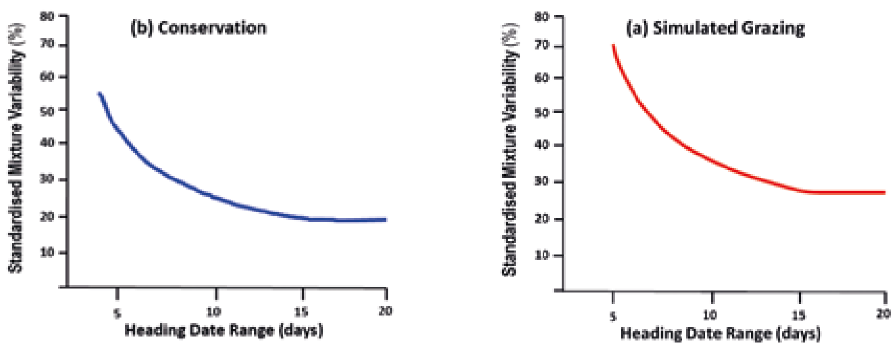
The outcome of the study was that when the component perennial ryegrass varieties had too wide a spread of different heading dates, the yield was negatively impacted. If the spread of heading dates was more than 7 days under a silage management, yield was depressed as it was more difficult to retain a high grass quality as the sward bulked up to the first cut. There was more ‘flexibility’ under grazing management as yield was not affected until the heading range between varieties was more than 15 days.

Figure 1: Yield differences between predicted and actual mixture yields as a function of the heading dates range



Furthermore, mixtures with a heading date range of 7 - 15 days showed a benefit in better distributing the yield across the grazing season and a lower year-to-year variation in dry matter yield, (Figure 2).

Figure 2: The relationship between the heading date range of commercial mixtures and the annual variation in yield



In all these studies it was found that the mixtures changed from their seed bag proportions after they were sown. This occurred largely in the first full growing season and in addition to the changing proportion of diploid to tetraploid, the earlier heading varieties tended to be more dominant in silage swards and less aggressive in grazing swards compared to the later heading varieties.

Farming guidance

The management implications of these findings are that: limiting heading date range is more critical under silage management than grazing; there is better year to year yield stability with a range of heading dates; tetraploids will be more aggressive than diploids in the mixed sward, with 30% tetraploid at sowing resulting in approximately 50% in the sward. Therefore, seed mixtures are designed to offset the competitive diploid:tetraploid and earlier:later heading interactions to produce swards with the desired final proportion of varieties for the intended sward use. Farmers should therefore have a clear understanding of what they expect their new sward to provide in terms of silage timing or grazing seasonality, so that the seed merchant or advisor can identify the correct compilation for that use.

FRESH GRASS ANALYSIS

HOW DO YOU SAMPLE YOURS?

Andrew Dale, Alan Gordon, John Archer and Conrad Ferris

Key Messages

- Grass analysis is an essential tool in managing grazing livestock and it is important robust results are achieved from fresh grass analysis.
- A number of factors such as storage time and handling may impact on grass quality shortly after grass sampling and before analysis.
- To achieve robust results from grass analysis– select the grass sample using scissors or clippers, aim to submit samples early in the week to minimise time delay and place samples in plastic bags, squeezing out air to minimise changes in grass quality.

Background

In order to optimise production from grazed grass, leading grassland farmers will often collect samples from their fields and submit to laboratories for analysis. This fresh grass analysis of grass dry matter (DM), crude protein (CP), water soluble carbohydrate (WSC) and metabolisable energy (ME) content, is a valuable means of managing grazing cow diets throughout the season. Samples are normally analysed using Near Infrared Reflectance Spectroscopy (NIRS). While NIRS can accurately predict the composition of fresh grass, many factors such as sample packaging and handling may contribute to changes in the composition of the grass between the time of harvest and analysis in the laboratory. The impact of these factors on the nutrient content of fresh grass, as determined by NIRS, remains largely unknown, and yet if significant changes take place during storage, the relevance of the results to in-field conditions is brought into question.

Research study details

A study was undertaken to examine the effect of harvest method, storage duration, storage temperature and storage conditions on the composition of fresh grass analysed by NIRS. Grass swards were harvested under a simulated grazing regime. Twenty-six treatments were examined at each simulated grazing harvest, with the key factors examined comprising:

- Harvesting technique (Pluck or Cut)
- Storage duration (Immediate analysis, 24-hour or 48-hour)
- Storage temperature (Ambient (average, 15.2°C) or Chilled (4°C))
- Storage conditions (Air present, Air excluded or Breathable)

All samples were analysed fresh using NIRS, with the dry matter (DM), crude protein (CP), water soluble carbohydrate (WSC), acid detergent fibre (ADF) and metabolisable energy (ME) content of the grass determined.

Research findings

Grass samples harvested by hand plucking had a higher CP (8 gkg DM^{-1}) and ME (0.05 MJkg DM^{-1}) content, and a lower ADF (3 gkg DM^{-1}) content, compared to those harvested by cutting. This was likely due to the lower cutting height with the latter.

Samples which were stored for 48-hours prior to analysis, had a lower WSC (9 gkg DM^{-1}) and ME content (0.12 MJkg DM^{-1}) and a higher ADF content (6 gkg DM^{-1}) than those subject to immediate analysis. There was no difference between the chemical composition from samples stored for 24-hours prior to analysis and those assessed immediately after cutting.

Samples that were stored at ambient temperature prior to analysis, had a lower WSC (12 gkg DM^{-1}) and ME content (0.17 MJkg DM^{-1}) compared to those analysed immediately.

Samples that were stored under 'Breathable' conditions had a lower ME content (0.10 MJkg DM^{-1}) and higher ADF content (5 gkg DM^{-1}) than those analysed immediately or stored with Air present or Air excluded. Storing grass under Breathable conditions resulted in an increased deterioration of the sample compared to samples stored in sealed bags, irrespective of whether air was present or excluded. Therefore, it is recommended that samples are stored in 'sealed bags' prior to analysis.

Farming guidance

Storage duration, storage temperature and storage conditions can all individually influence grass composition, with changes most evident when samples were stored for 48-hours, stored at an ambient temperature and stored in breathable conditions When taking grass samples, farmers should aim to:

- Use scissors to cut the samples of the sward to the target residual height
- Place samples in a sealed bag, excluding as much air as possible
- Place any stored grass samples in the fridge
- Take samples early in the week and place in the post first class to minimise time between sampling and analysis

These storage principles will equally apply to silage samples being sent for NIRS analysis

Footnote: This study was funded by AHDB Dairy, as part of the AHDB Dairy Grassland, Forage and Soils Research Programme.

FRESH GRASS ANALYSIS

WITH MOBILE NIR DEVICES

Lewis Patton, Debbie McConnell and Trevor Gilliland

Key messages

- Fresh grass analysis is an essential tool in managing grazing livestock and so robust accurate results are needed.
- New technologies for in-situ measurement of forage qualities using near infrared spectroscopy (NIR) are being developed for use on-farm.
- None of the technologies examined accurately replicated laboratory NIRS predictions for four grass quality parameters.
- All instruments were unable to accurately predict extremes of forage quality
- Further development work is required to achieve laboratory NIRS accuracies.

Background

To optimise production from grazed grass by ensuring it is ensiled at the optimum time, farmers submit samples for laboratory analysis of dry matter (DM), crude protein (CP), water soluble carbohydrate (WSC) and metabolisable energy (ME) content, by near-infrared reflectance spectroscopy (NIRS). Recently, portable NIRS instruments have emerged as a novel technology offering the potential to provide real-time forage quality predictions. Whilst these machines have undergone some testing on ensiled forages, little is known about their ability to accurately determine the quality of fresh grass.

Research study details

A total of ninety-six perennial ryegrass samples were collected between April and August 2017 from both commercial farms and on-going AFBI research trials. Samples were analysed for a range of nutritive characteristics using a laboratory NIRS instrument (NIRSystems 6500, Foss, Hillerod, Denmark). Subsets of these samples were also scanned through three commercially available, portable NIRS instruments from different manufacturers: Instrument A (60 samples), Instrument B (34 samples) and Instrument C (72 samples. The scanning methods varied according to the manufacturer's instructions for each instrument. For each sample, mean dry matter (DM), crude protein (CP), acid detergent fibre (ADF) and water-soluble carbohydrate content (WSC, excluding Instrument C) was determined and is summarised in Figures 1-3.

Research findings

Two instruments (A & B) consistently over-predicted grass DM content on average by 2.84 and 0.49%, respectively compared to laboratory analysis. In contrast Instrument C returned comparable results to that recorded from laboratory NIRS, however all three instruments showed a smaller range of values compared to the laboratory datasets (as indicated by minimum and maximum bars on each graph). This indicated that the mobile NIR instruments were less accurate when scanning very high or low dry matter herbage.

Instruments B and C again over-predicted grass CP content on average by 7.75 and 3.16%, respectively. This over-prediction could lead farmers to significant under-feed supplementary concentrates to meet animal requirement and impact on milk production. Similar to DM content, across all three mobile instruments, the range of CP was not in close agreement with the laboratory results, as it was on average range 6.75% less.

All three mobile NIR instruments under-predicted grass ADF content by an average of 4.87%, compared to the reference laboratory values. Once again the range of values were also smaller than that received from laboratory NIR. For WSC, Instrument A provided a robust measurement compared to laboratory results however this was not achieved by Instrument B, which under-predicted WSC content by 10.13% on average.

Practical implications

Overall no instrument accurately replicated laboratory NIRS predictions for all four grass quality parameters. Under and over-prediction of values was particularly evident when high and low value herbage was being scanned, suggesting that further work must be done to adapt the calibration equations used in the mobile devices to accurately reflect grass quality typical of that collected on N.I. farms.

Footnote: The commercial companies are thanked for the provision of the mobile NIR equipment used in this study.

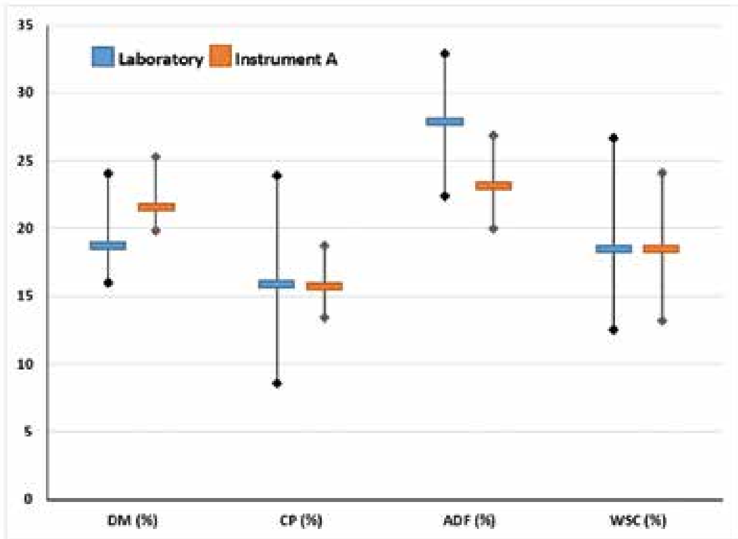


Figure 1: Average (bar) and minimum/maximum (line) values of 60 grass samples analysed by standard laboratory or mobile NIR instrument A for dry matter (DM), crude protein (CP), acid detergent fibre (ADF) and water soluble carbohydrates (WSC).

Figure 2: Average (bar) and minimum/maximum (line) values of 34 grass samples analysed by standard laboratory or mobile NIR instrument B for dry matter (DM), crude protein (CP), acid detergent fibre (ADF) and water soluble carbohydrates (WSC).

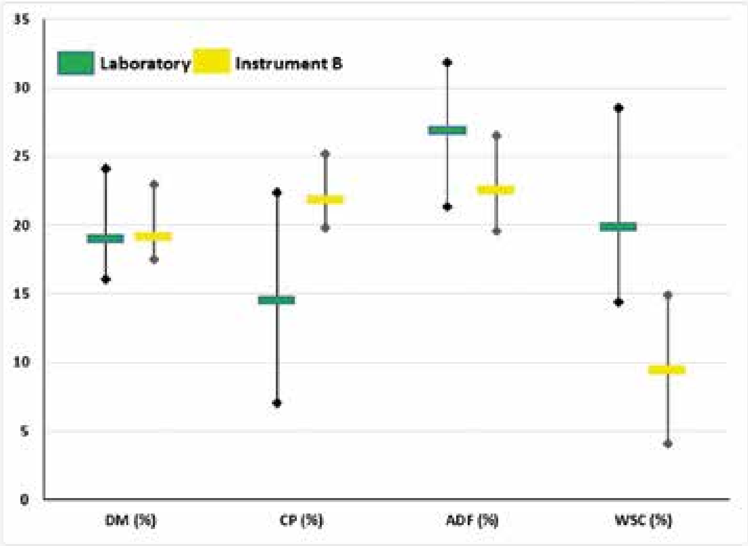
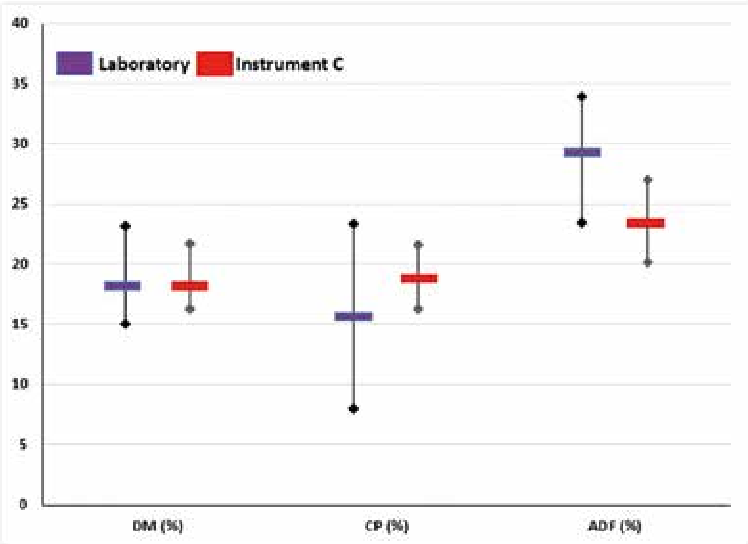
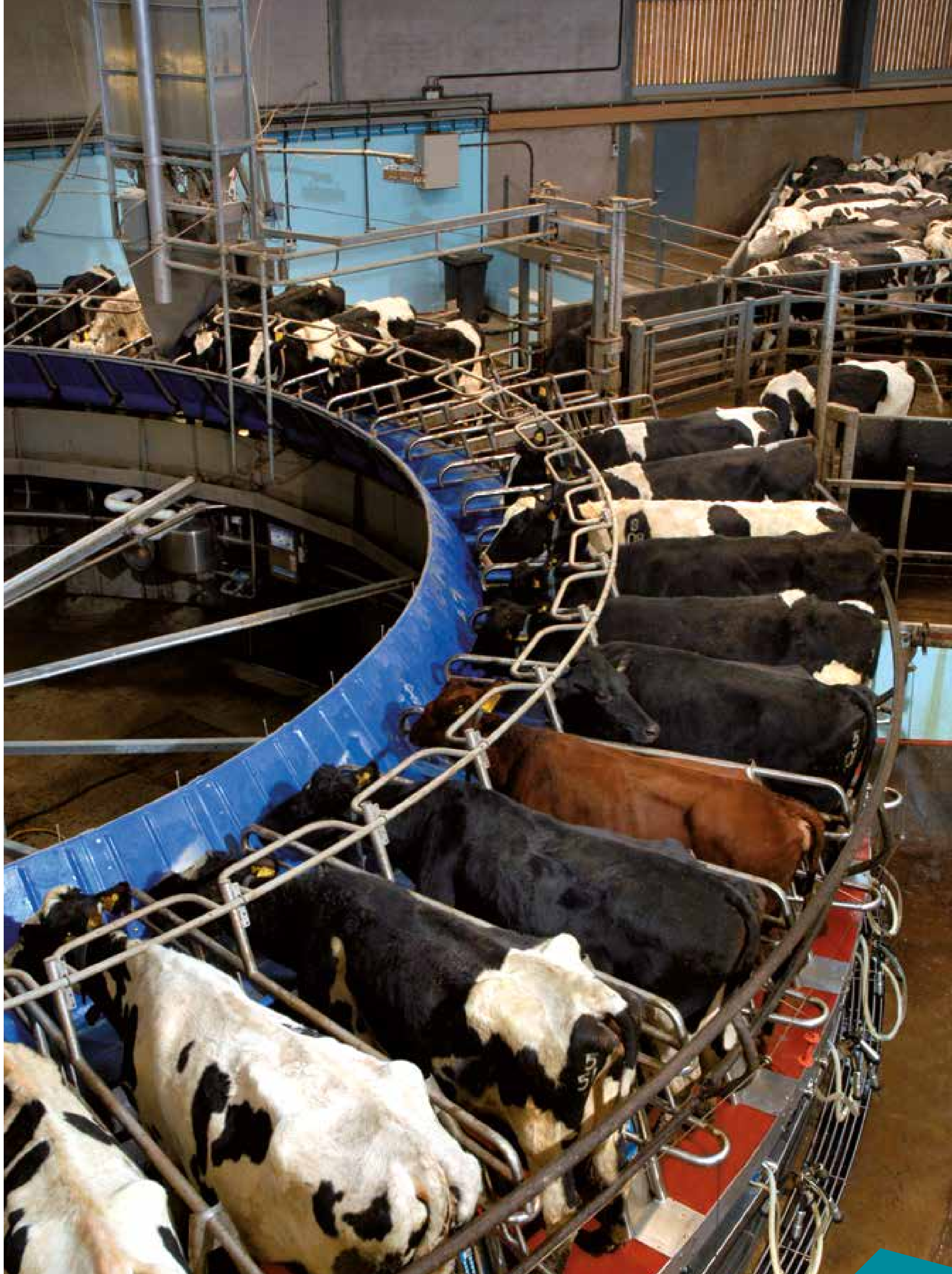


Figure 3: Average (bar) and minimum/maximum (line) values of 72 grass samples analysed by standard laboratory or mobile NIR instrument C for dry matter (DM), crude protein (CP) and acid detergent fibre (ADF).





SEED MIXTURE COMPOSITION

FOR LOWER NITROGEN REGIMES

David Patterson

Key messages

- commercial seed mixtures can vary widely in composition, therefore care is needed when combining herbage species in seed mixtures
- perennial ryegrass-based seed mixtures are the default option when reseeding
- where nitrogen inputs are lower, white clover must be the first choice companion species for use with perennial ryegrass

Background

Current approaches vary widely when it comes to deciding on the most appropriate seed mixture composition. Extremes range from sowing a single variety such as a late heading tetraploid perennial ryegrass variety in an intensively managed dairy cow paddock right through to complex multi-species mixtures with more than one grass species included along with clovers and herbs such as plantain and chicory.

However the majority of commercial seed mixtures currently used across Northern Ireland dairy farms are based on highly productive perennial ryegrass varieties, mostly intermediate and late heading diploid and tetraploid varieties. It must be emphasised that these high performance swards require optimum management in terms of soil health and nutrient status as well as high fertiliser input to achieve the correct balances of N, P, K and sulphur, in order to produce the high yields under both grazing and cutting regimes. The Nitrates Action Programme 2015-2018 and Phosphorous Regulations guidance booklet states that dairy farms can apply up to 272kgN/ha per year. If insufficient nutrition is supplied to these high yield potential swards their performance will deteriorate and become less competitive in the sward allowing ingression of weed grasses and broad leaf weeds. If a farm is operating at lower levels of nitrogen input then consideration must be given to inclusion of other species in the seed mixture.

The case for white clover

The first 'other' species that is included in mixtures is often white clover. Usage has fallen in recent years partly due to high dependence on nitrogen to drive production but also due to the lack of effective clover-safe herbicides. Farmers often feel it is pointless sowing clover if they end up having to spray it out to control docks. However, AFBI research has shown that a perennial ryegrass/white clover sward can be as productive as grass-only swards receiving medium to high fertiliser nitrogen as it can fix approximately 150kgN/ha per year. In a study carried out at Hillsborough, a grass/clover sward which received no nitrogen fertilizer had the same stock carrying capacity as a

Harvesting of grass clover plots

grass sward fertilized with 170kgN/ha. Other AFBI studies found that with low levels of slurry nitrogen applied, a perennial ryegrass/white clover mixture out-performed a ryegrass-only sward and a low input multi-grass species mixture (cocksfoot/ Timothy/ ryegrass/ meadow fescue). White clover works well on farms where there is the potential for a long backend grazing season. Farms with the potential for cows out grazing until late October/November will benefit from the contribution of clover in the sward.

Which ryegrasses work best along with white clover?

The vast majority of perennial ryegrass varieties have heading dates from around mid-May through to mid-June. The general recommendation has been to include a high proportion of late-heading diploids with white clover. Late-heading varieties also tend to have a lower proportion of stem in the herbage during the late spring and early summer.

White clover contribution to the sward is highest in August and September. It will die back during winter and makes a limited contribution to the sward in spring. The net result is a more open sward during winter. Late-heading diploid varieties will produce dense, persistent swards and their inclusion with clover can help to increase overall sward density.

When it comes to the ploidy level (diploids and tetraploids) AFBI research has shown that tetraploid varieties are more compatible with white clover because of their more open growth habit. However their exclusive use in a mixture can result in a very open sward which in turn leaves it vulnerable to treading and poaching damage and lowers the overall sward persistency. Therefore they should not comprise more than a third of the seed mixture for use on the majority of swards in Northern Ireland.

Timothy – the clover tolerant grass

Research has also shown that Timothy can out-perform perennial ryegrass at low nitrogen levels and that clover content is higher when Timothy is included in the seed mixture. Timothy is particularly well suited to later sites with heavier soil type, An ideal grass-clover seed mixture should have late heading diploids, with late tetraploid varieties in the minority along with the inclusion of Timothy.

Close-up of sward with good white clover content

Farming implications

Perennial ryegrass will continue to form the mainstay of highly productive seed mixtures under both grazing and cutting management under optimum nitrogen regimes. It is easy to 'follow the crowd' and sow whatever is the leading ryegrass mixture, without consideration the level of nitrogen use normally used on the farm. Unless the plan is to push the new sward to its optimum with high-N fertilizers and slurry, then AFBI research clearly shows that the inclusion of clover in the seed mixture and selecting a seed mixture designed to be white clover tolerant will produce a better sward performance than a pure perennial ryegrass compilation.

OPTIMUM MAINTENANCE

PLUS VALUES FOR GRAZING DAIRY COWS

Andrew Dale, Peter Purcell and Conrad Ferris

Key messages

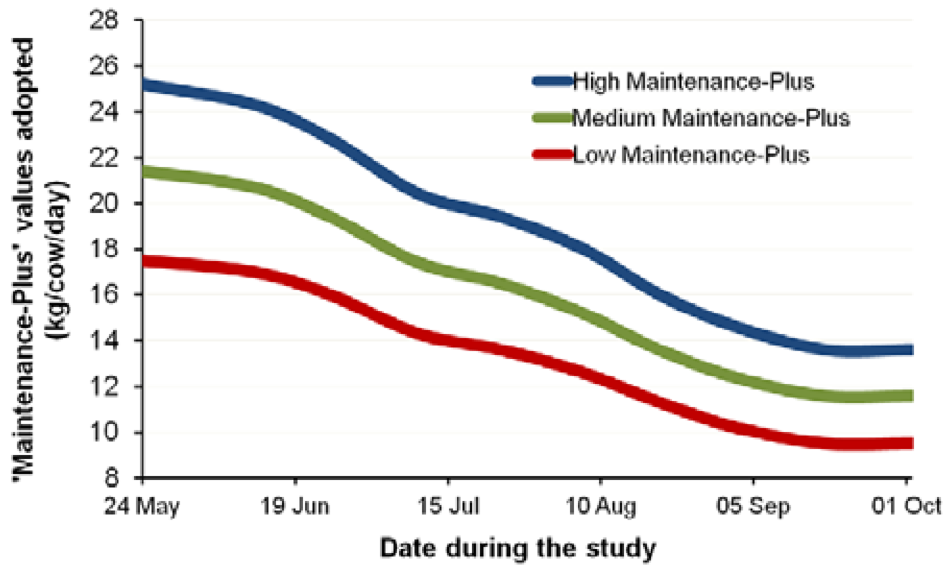
- Selecting appropriate maintenance-plus (M+) values for grass is important to reduce concentrate consumption whilst maintaining animal performance.
- Adopting a Medium M+ value curve (starting at 21kg/cow in May and falling to 13kg/cow) offered a good balance between reducing feed cost and maintaining cow performance.
- High M+ values will reduce concentrate intake per cow but resulted in thinner, lighter cows over the course of the study.

Background

If efficiently utilised, grazed grass remains the lowest-cost feed for dairy cows in N.I. Thus, achieving high levels of cow performance from grazed grass should remain an important target for N.I. dairy farms. Indeed, studies at AFBI Hillsborough have demonstrated that, when offered as the sole feed, grazed grass can sustain daily milk yields of up to 27kg per cow in late May, declining to 14kg per cow by late September. However, the milk-yield potential of most Northern Ireland dairy cows has increased considerably during the last few decades, and consequently grazed grass as the sole feed is frequently unable to meet their energy requirements during the grazing season. When supplementary concentrates are introduced to address this energy gap, grass intake will decline. Currently, there is little information on the milk yields of cows that can be sustained from grazed grass (the 'Maintenance-Plus' or M+ value) when supplemented with moderate or high levels of concentrates. A study was designed to examine the effect of adopting high, medium, or low M+ values on concentrate requirements and cow performance of grazing dairy cows.

Research study details

This study involved 72 Holstein-Friesian cows (24 in first lactation), assigned to either 'Low', 'Medium', or 'High' M+ values at 12.7, 15.4, and 18.1kg/cow/day, respectively (values for the first-lactation heifers were 20% lower). The study started on 24 May and finished on 2 October. The late start date was due to the exceptionally poor weather during spring. Cows were an average of 159 days calved, and had an average daily milk yield of 32kg per cow, at the start of the study. Concentrates were offered on a 'feed-to-yield' basis. The allocation was adjusted fortnightly during the study to account for changing M+ values and individual cow milk yields. Concentrates were allocated to individual cows at a rate of 0.45kg for every litre of milk produced above their assigned M+ value.



Research findings

The total concentrates offered were 645, 408, and 242kg per cow for the Low, Medium, and High treatments, respectively, with estimated grass dry matter intakes (DMI) of 10.4, 11.4, and 12.4kg DM per cow per day.

Moving from High to Medium M+ values increased concentrate usage however milk yield and milk fat-plus-protein yield both increased significantly (Table 1). Cows with the greatest reliance on grazed grass (High M+) were thinner and lighter at the end of the study. If the body-tissue reserves of these thinner cows cannot be restored during the late-lactation period, they may have an increased risk of health and fertility problems during their next lactations.

Moving from Medium to Low M+ values achieved the greatest milk yield however there was no significant increase in fat-plus-protein yield. Hence caution is required when adopting very low M+ values, as the additional concentrates required may not necessarily result in an increase in cow performance.

At a milk price of 27 pence per litre and a concentrate cost of £250 per tonne, margin over feed costs were £5.02, £4.92 and £4.54 for the High, Medium and Low M+ values respectively.

GRASSCHECK

GRASS GROWTH AND QUALITY MONITORING

Debbie McConnell and Francis Lively

Key messages

- Grass growth during 2017 was 23% higher than the long-term average however the shape of the grass growth curve varied significantly between counties.
- Regardless of production system, on-farm data shows it is possible to achieve over 10t DM/ha/year of grass production on dairy farms in Northern Ireland.
- Reviewing average farm covers and the GrassCheck growth forecasts regularly will help manage grass surpluses and deficits throughout the grazing season.

Background

Currently the average dairy farm in Northern Ireland grows and utilise around 7.5 tonnes of dry matter per hectare (t DM/ha). This equates to 50% of the yield achievable by modern day grass varieties and suggests a lost opportunity to reduce feed costs and improve net margin. Recent AFBI estimates suggest that by improving grass utilisation by 1t DM/ha and by improving grass quality, an extra profit of £334/ha/yr could be realised on the average dairy farm in Northern Ireland. To maximise the use of grass within dairy systems, regular grass growth and quality monitoring is an essential tool which needs to be completed throughout the growing season.

GrassCheck was originally established in 1999 to provide information on typical grass growth rates throughout the growing season. This data can be used in conjunction with individual farm data to benchmark grassland performance. Ongoing collection of this information each year is crucial in understanding grass growth and quality across N.I. Since 2005, 7 and 14 day grass growth rate forecasts have also been published to assist farmers in planning grazing management.

GrassCheck monitoring

The main GrassCheck plot data is generated from four sets of monitored plots, managed under a simulated grazing regime, located at AFBI Hillsborough and CAFRE Greenmount. Plots are located on established perennial ryegrass swards and receive 270 kg N/ha, as there is no return of animal manures. Plots are cut on a three week rotation. Grass growth forecasts are generated weekly using the AFBI GrassCheck model with inputs of rainfall, solar radiation, temperature forecasts and planned nitrogen application.

In addition to this, 12 commercial dairy farms and 18 beef farms were recruited to monitor grass growth and quality throughout the 2017 grazing season. These dairy farms span a range of land types (from severely disadvantaged areas to prime lowland), grazing system (paddock grazing to zero-grazing), milk output (5000-9000 litres/cow) and different calving systems. Weekly grass growth data is recorded across their grazing platform and entered onto AgriNet, with grass quality was measured fortnightly. Each farm is equipped with an automatic weather station, providing measures of temperature, solar radiation, soil temperature and moisture content, rainfall and wind.

Information is published weekly in the local farming press, online (agrisearch.org/grasscheck) and on social media (Facebook and Twitter, @GrassCheck).

2017 grazing season

During 2017, grass growth was 23% higher than the long-term average, with GrassCheck plots recording 13.8t DM/ha over the year with an average growth rate of 55.9kg DM/ha/day (Figure 1). This additional growth was recorded during June, July and August with an extra 1.78t DM/ha grown during this time. Grass quality was high from March to July averaging 17.2% DM, 20.0% crude protein (CP) and 11.6 MJ/kg DM metabolisable energy (ME). However during September and October, grass DM, CP and ME contents fell to 12.3%, 18.5% and 10.7 MJ/kg DM, respectively, significantly reducing potential milk yield from grazed grass.

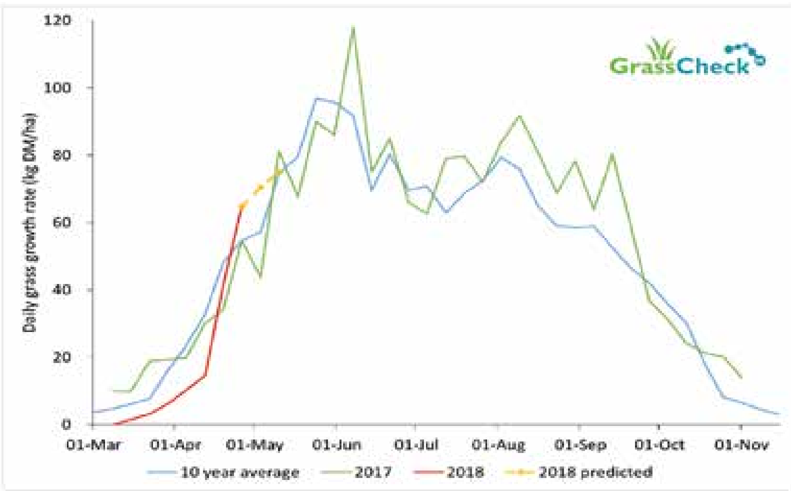


Figure 1: Grass growth curve for 2017 and 2018.

On-farm, high levels of grass growth were also observed last year across the 12 GrassCheck farms, averaging 11.8t DM/ha. Grass utilisation on farm was a major challenge due very high levels of rainfall over the summer months. On average, 50% more rainfall fell across Northern Ireland between July and September than the long term average. However all farms achieved over 10t DM/ha utilised (Table 1), regardless of land type or farm system. (Beef farms also observed good growth and on average measured 11.1t DM/ha).

Although there was no significant difference in total grass growth between counties, the grass growth profile varied considerably. During April - May 2017, significantly drier conditions in counties Armagh and Down reduced grass growth by 0.9t DM/ha compared to other counties (Figure 2). In contrast, grass growth rates rose sharply during this time in the West, reaching growth in excess of 120kg DM/ha/day. This highlights the need for regular measurement on farm to ensure grass growth profiles are managed appropriately.

Table 1: Total grass growth recorded on GrassCheck farms over the grazing season.

Farm Number	Calving pattern	Grass yield (t DM/ha)
3	Spring	10.2
1	Spring	12.0
7	Spring	15.3
10	Autumn/Spring	12.5
2	Autumn	10.2
6	Autumn	11.1
12	Autumn	11.4
8	Winter	10.7
9	Winter	11.0
4	Winter	11.5
11	Winter	11.9
5	All year round	13.6

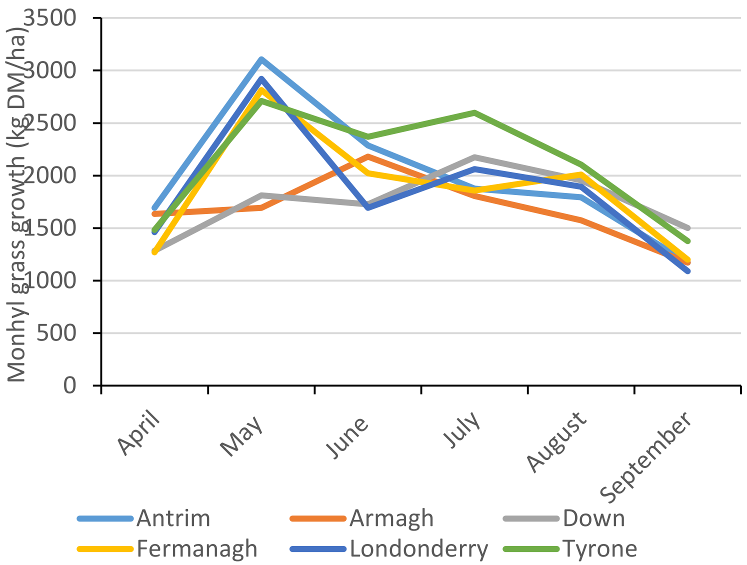


Figure 2: Monthly grass growth across counties during 2017

GrassCheck 2018

A further eight dairy (plus five beef and five sheep) farms have been recruited for the 2018 grass monitoring season, giving an even greater geographical coverage across Northern Ireland (Figure 3). So far this year, grass growth in spring has been significantly behind normal levels, largely due to low temperatures in March. Initiation of grass growth was 2.5 weeks later than that recorded in 2017. Total growth for March was only 97kg DM/ha, one third of that usually recorded (288kg DM/ha). Although some recovery was observed in April, total growth during the month was still 10% behind the ten year average (Figure 1).

Figure 3: Location of GrassCheck dairy, beef and sheep monitor farms for 2018.

Farming guidance

Grass growth during 2017 was 23% higher than the long-term average however the shape of the grass growth curve varied significantly between counties. The 2018 grass growing year started out very differently to 2017, proving that what worked well last year can't be assumed to work the following year. So Grassland farmers need to be monitoring their average farm covers and checking the GrassCheck growth forecasts regularly to be forewarned of the expected growth for the coming fortnight. With this knowledge, they can effectively manage grass surpluses and deficits throughout the grazing season and aim to produce over 10t DM/ha/year of grass production, which GrassCheck farms have proven is achievable in Northern Ireland.

Footnote: Funding from AgriSearch, DAERA and CIEL is gratefully acknowledge

ZERO-GRAZING

HOW DOES IT COMPARE?

Gillian Scoley and Debbie McConnell

Key messages

- Implementing a zero-grazing strategy during the spring and summer months can offer improvements in milk production and quality compared with grazing and silage based systems
- Feed costs and grass utilisation remained lowest within grazing systems offering the highest margin over feed and forage per cow but lowest margin over feed and forage per hectare values, compared with zero-grazing or silage systems
- In all systems, focusing on increasing grassland productivity and utilisation is key to improving profitability

Background

Feed and forage costs remain the largest driver of profitability on UK dairy farms. Fluctuations in the availability and cost of purchased feeds has fuelled an increased interest in zero-grazing, owing to its potential to make use of fragmented land, the possibility of lower feed cost of housed cows and a perceived improvement in grass utilisation throughout the year. Recent research has found that replacing TMR with zero-grazed grass has offered the potential to improve margin over forage and feed costs, however, little is known about zero-grazing relative to silage feeding or grazing systems. A study was designed to compare both animal performance and cost of production between cows managed in a conventional grazing system and housed cows offered either grass silage or zero-grazed grass.

Research study details

This study involved 114 Holstein-Friesian, 29 of which were in their first lactation. The study started on 15 April and finished on 25 September 2016. Cows were split into 3 groups and assigned to either a conventional grazing system (G) or full time housing and fed either grass silage (S) or zero-grazed grass (ZG). Grazed cows were managed in a rotational system and offered fresh grass daily. Targeted pre- and post-grazing herbage masses were 3200 and 1800kg DM/ha respectively. For zero-grazing, fresh grass was cut on a daily basis using specialist zero-grazing machinery, with targeted pre-cutting herbage masses of 3200-3800kg DM/ha. Cows on all treatments received 6.4kg DM/day concentrates through the parlour, with crude protein contents of 18 and 20% for cows consuming fresh grass or grass silage respectively. Animal performance, milk production and milk quality along with grass growth and utilisation were measured throughout the study.

Research findings

Cows managed on a zero-grazing system consumed up to 1kg DM/day more forage than those managed in a grazing system or full time housed and fed grass silage. When compared with silage fed and grazed cows, the higher zero-grazing intakes resulted in milk yield improvements of 1.6 and 3.8kg/day and a lift in milk fat-plus-protein yield of 0.33 and 0.14kg/day, respectively (Table 1). Cows offered zero-grazed grass also maintained a consistent weight advantage (Table 1) over those managed in a grazing system. This was likely due to the combined effects of increased forage intake and lower energy expenditure due to reduced daily step count.

When compared with those offered grass silage, cows offered zero-grazed grass had improved milk production and quality which resulted in an increased milk value and margin over forage of £174/cow and £146/cow increased feed costs. Although milk value was comparable between zero-grazed and grazed cows, the reduced feed costs in grazed cows resulted in higher margin over forage and feed costs per cow. However, if the improved grass production and utilisation in silage based and zero-grazed systems is taken into account, both of which offer the potential for an increase in stocking rate of up to 1.9 cows/ha, there is a resultant improvement in margin over feed and forage costs of up to £338/ha, compared to conventional grazing systems. This highlights the importance of seeking to drive high grass utilisation in grazing systems as a means of generating improvements in profitability.

Table 1. Performance of cows maintained in grazing, zero-grazing or silage based system

	Silage	Zero-Grazed	Grazing
Forage intake (kg DM/day)	11.6	12.1	11.2
Daily Milk Yield (kg/day)	25.7	29.5	27.9
Fat + Protein Yield (kg/day)	1.82	2.15	2.01
Live weight (kg)	589.1	616.9	585.5

Table 2. Cash cost comparison of dairy cows managed in a grazing system or with silage or zero-grazed grass as the sole forage source

	Silage	Zero-grazing	Grazing
Milk value (£)	1037	1211	1198
Feed costs (£)	416	449	340
Margin over feed and forage (£/cow)	616	762	858
Grass grown (t DM/ha)	11.9	11.1	10.8
Grass utilisation (%)	80.0	76.5	70.4
Stocking rate (cows/ha)	5.68	4.70	3.78
Margin over feed and forage (£/ha)	3500	3580	3242

*Cash cost assumptions = concentrate cost = £243/t DM, base milk price = 27ppl.

Farming guidance

Zero-grazing offers improvements in both milk production and quality when compared with conventional grazing and silage based systems. Seeking to drive improvements in grass utilisation and production is key to increasing profitability in grazing systems. Given the initial costs of specialist zero-grazing equipment, and the variability in efficiency of grass production systems between farms, decisions on whether to zero-graze must be considered on a farm by farm basis. Critical to this consideration is to assess the efficiency of the current grazing system employed and if the land type would support additional cutting days when grazing would not be possible.

Footnote: This study was funded by AgriSearch and the Department of Agriculture, Environment and Rural Affairs (DAERA).

ZERO-GRAZING

DOES MACHINERY TYPE MATTER?

Gillian Scoley and Debbie McConnell

Key messages

- Grass dry matter intake (DMI) was 0.6kg DM/cow/day higher from specialist zero-grazing machinery compared to double chop techniques
- Daily milk yields were 0.4kg/cow/day lower from the double chop technique, but there was no impact on milk quality
- There was no difference in grass growth or utilisation, however, grass quality offered was marginally lower from double chop
- Longer chop length in grass harvested with specialist zero-grazing machinery resulted in cows spending increased time at the feed bunk – take care to provide sufficient feed space

Background

With growing interest in improving grass utilisation and increasing the opportunities to include fresh grass in the diet of dairy cows, strategies such as zero-grazing are becoming more widespread. Although specialist machinery has been developed for zero-grazing systems, these can be quite costly and as such some producers have opted to use more traditional, cheaper alternatives such as double chop harvesters. However, mechanical damage as a result of harvesting method can impact the nutritive quality of grass post-harvest, thus potentially affecting nutrient intake and therefore impacting on animal performance. Recent research from AFBI aimed to assess the impact of two different cutting regimes on both animal and grass performance.

Research study details

This study involved 40 Holstein-Friesian cows, 10 of which were in their first lactation. The study commenced on 30 May and finished on 31 August 2017. Cows were an average of 102 days calved and had an average daily milk yield of 35kg per cow at the start of the study. Cows were full time housed and split into two groups to be fed fresh grass harvested using either a double chop harvester (DC) or specialist zero-grazing machinery (ZG). Fresh grass was harvested each morning and offered to cows twice daily following morning and afternoon milkings. Average rotation length across treatments was 28 days. All cows received concentrates via out of parlour feeders (7 and 4kg/day for cows and heifers, respectively) plus an additional 4kg/day in the parlour during milking. Animal performance, feeding behaviour and activity, as well as grass quality and utilisation, were monitored throughout the study.

Research findings

The results indicated that providing cows with grass cut using specialist zero-grazing machinery increased daily intake by 0.6kg DM/day and milk yield by 0.4kg/day (Table 1). However there were no differences in milk quality. In-field grass utilisation, growth rate and rotation length were similar across both treatments. Although there were observable differences in sward integrity following cutting with the double chop harvester (Figure 1), reduction in grass quality was minimal. However, when measured over the 48 hours following cutting, a reduction in grass quality was recorded. This was due to a greater loss of both WSC and DM and so a greater proportion of ADF in the double chopped sward compared to the sward cut with specialist zero-grazing equipment.

Table 1. Cow performance and grass quality

	Double Chop (DC)	Zero-Grazed (ZG)
Daily milk yield (kg/day)	31.5	31.9
Milk fat-plus-protein yield (kg/cow/day)	2.35	2.36
Grass intake (kg DM/day)	13.7	14.3
Grass DM content (%)	14.2	14.8
Grass ME content (MJkg DM)	10.85	11.00
Grass ADF content (gkg DM)	31.5	30.7
Fresh grass chop length (cm)	13.8	26.5

Feeding management factors such as chop length can influence feeding behaviour, with the potential to impact on animal performance. Rumination time was slightly increased in cows offered zero-grazed grass, which was likely due to the increase in fresh grass chop length. Cows offered zero-grazed grass spent over 20 min/cow/day longer at the feed bunk than those offered double chopped grass, displaying increased feed sorting behaviour due to the longer grass particle length. This highlights the importance of considering feed space allowance in relation to feed type to ensure that feeding behaviour and therefore potential intake is not limited.

Table 2. Feeding behaviour of cows offered zero-grazed or double chopped grass

	Grass Harvesting Method	
	DC	**ZG**
Time at feed bunk (min/cow/day)	258.0	279.7
Eating time (min/cow/day)	453.2	453.9
Rumination time (min/cow/day)	482.7	493.2
Eating (min/kgDMI)	19.7	20.2
Ruminating (min/kgDMI)	21.0	22.0

Figure 1. Double chop (LHS) vs zero-grazed grass (RHS).

Farming guidance

As grass utilisation was unaffected by harvesting machinery, and only minimal differences in grass quality at the time of cutting were observed, this means farmers can make choices based on the evidence above. However, use of specialist zero-grazing machinery can offer the opportunity to increase milk production as a result of increased dry matter intake. In practice, the onset of deterioration in grass quality of the double chopped sward over 48 hours following cutting, highlights the importance of feed budgeting so as to minimise grass wastage on farm and maintain grass quality. It is important to provide an adequate feed space allocation to ensure that potential dry matter intake and feeding behaviour is not limited.

Footnote: This study was funded by AgriSearch and the Department of Agriculture, Environment and Rural Affairs (DAERA).

ZERO-GRAZING

KNOW WHEN TO MOW

Gillian Scoley and Debbie McConnell

Key messages

- Maintaining zero-grazing covers below 3500kg DM/ha increases grass quality, grass growth and total grass utilisation compared with sward covers exceeding 4500kg DM/ha
- Feeding zero-grazed grass from sward covers below 3500kg DM/ha can increase cow intake, milk production and milk quality when compared with cows fed grass from high cover swards
- Maintaining zero-grazing pre-cutting covers of 3500kg DM/ha resulted in a £0.57/cow/day increase in margin over feed and forage, compared with high covers

Background

Fresh grass remains the cheapest feed source available for dairy cows and increasing its inclusion in the diet can help reduce overall feed costs. Grazing high cover swards can be challenging due to the associated negative impacts on grass quality and utilisation. Zero-grazing offers the opportunity to cut at higher grass covers (>3500kg DM/ha) than would be used in conventional grazing systems, however, it is important to consider the impact of using high covers on animal performance and grass utilisation. A study was designed to compare the performance of cows offered fresh grass from low (~3500kg DM/ha) or high (~4500kg DM/ha) cover swards and also measure how this affected sward productivity.

Research study details

This study involved 40 Holstein-Friesian cows, 16 of which were in their first lactation. The study started on 14 June and finished on 30 September 2017. Cows were an average of 119 days calved and had an average daily milk yield of 29kg per cow at the start of the study. Cows were full time housed and split into two groups to be fed either fresh grass harvested from low cover swards or high cover swards. Fresh grass was harvested each morning using specialised zero-grazing machinery and offered twice daily following the morning and afternoon milkings. All cows received additional concentrate feeding in the parlour at a rate of 6.4 and 4.7kg DM/day for cows and heifers, respectively. Animal performance and eating behaviour along with grass quality, utilisation and growth were monitored throughout the study.

Research findings

Results indicated that grass quality was reduced in the high cover sward, with an increase in acid digestible fibre (ADF) and decrease in both metabolisable energy (ME) and crude protein (CP) content (Table 1). Feeding grass from the high cover swards had a negative impact on grass production, with an average reduction of 14kg DM/ha/day in grass growth rate when compared with the low cover swards. Total grass utilisation (field + feeding %) was also reduced by 5.7 % in cows offered the high cover sward, due to higher wastage at the feed face. Reduced grass quality lowered grass intake, and consequently cow performance. Therefore, cows on the low cover sward treatment consumed an extra 0.9kg DM/cow/day (Table 1) and displayed an increase of 1.8kg/day in milk yield, when compared to cows on the high cover sward treatment (Figure 1). Milk quality was also improved in the low cover sward treatment, with an increase of 0.2kg/cow/day in milk fat-plus-protein yield (Figure 1). Although intake was reduced in cows fed the high cover sward, time spent ruminating was increased by over 1 hour per day, which indicates a greater energy expenditure involved in the breakdown of longer forage particles.

The improvements obtained in both milk yield and quality in the low cover sward treatment resulted in an increase in profitability. If a base milk price of 28 ppl is used, margin over feed and forage for cows on the low cover treatment was £4.78/cow/day compared with £4.21/cow/day on the high cover treatment (concentrate cost= £213/t DM and zero-grazed grass cost= £90/t DM).

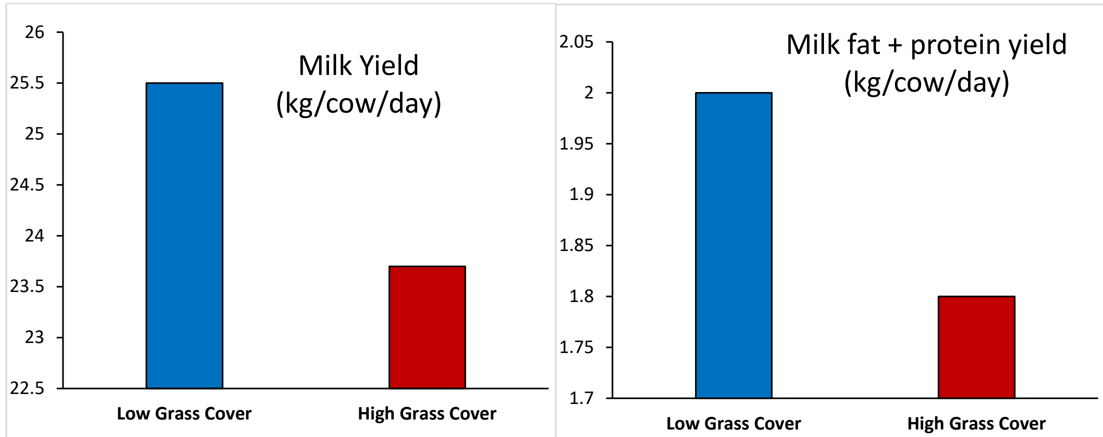


Figure 1. Average milk yield and milk fat + protein yield of cows offered grass from low or high cover swards

Table 1. Impact of targeting high and low pre-cutting sward covers on grassland performance

	Low grass cover	High grass cover
Rotation length (days)	25.9	46.1
Grass growth rate (kg DM/ha/day)	82.1	68.1
Total grass utilisation (Field + Feeding, %)	91.9	86.2
Grass intake (kg DM/cow/day)	13.8	12.9
Grass ADF content (%)	30.2	31.3
Grass ME content (MJ/kg DM)	11.1	10.9
Grass CP content (g/kg DM)	175	162

Farming guidance

The results from this study emphasise the impact of grass cover on cow performance and highlight the importance of grassland management when implementing a zero-grazing system. Aiming to maintain sward covers below 3500kg DM/ha will improve grass utilisation and cow performance with a resultant positive effect on profitability.

Footnote: This study was co-funded by DAERA and AgriSearch

MAKING THE MOST OF AUTUMN GRASS

Gillian Scoley and Debbie McConnell

Key messages

- Providing cows with zero-grazed grass during autumn increased dry matter intake, milk production and milk protein content in comparison with cows fed a silage based diet
- No residual benefits were observed when cows were transitioned to winter silage diets
- There was limited difference in feed cost and margin over forage and feed per cow between the two systems over the course of the study

Background

Extending the grazing season in autumn is typically worth £0.60/cow/day in reduced feed costs, however challenging soil and weather conditions can restrict farmers from achieving the full benefit of this price difference. Zero-grazing, by increasing the flexibility in the time of day of cutting and the potential to use a greater number of fields, can make it easier to harvest grass during the autumn months, potentially reducing the risk of poaching and soil damage when compared to grazing systems. However, little is known about the effects of including fresh grass in the diet of housed cows during the autumn period. Recent research conducted at AFBI, aimed to compare animal performance in cows offered autumn zero-grazed grass with those offered grass silage.

Research study details

The study involved 60 autumn-calving Holstein-Friesian cows, 16 of which were in their first lactation. The study was split into two periods; Autumn (8th September- 26th October) and Winter (2nd November-29th February). In the autumn period, cows were housed full-time and split into two groups and allocated to either a grass silage (S) or zero-grazed grass (ZG) based diet. In the winter period, all cows were transitioned to the same grass silage based diet. Concentrate feeding amounts were the same across treatments, with heifers increasing from 4.75-9.75kg/day and cows increasing from 6-13kg/day in the first 15 days post-calving via in- and out-of parlour feeders. Animal performance including feed intake, live weight, milk production and milk quality were measured over the 180 days of the study.

Research findings

Results indicated that although grass quality has previously been considered to be of low nutritive value over the autumn period, metabolisable energy content was consistently over 11 MJ/kg DM during September-November (Table 1). Offering fresh grass to cows increased dry matter intake by 1.8kg DM/day when compared to those offered grass silage and resulted in an increase milk production of 1.4kg/day (Table 2). Milk quality also improved, with an increase in milk fat-plus-protein yield of 0.1kg/day. The improvements in both milk yield and quality resulted in an increased milk value of £24/cow and margin over forage and feed cost of £9/cow for this 48 day period. Milk energy output was comparable across treatments, however cows offered zero-grazed grass maintained higher live weights than those offered grass silage. During the winter period, when both groups were offered grass silage, cows that had continuously been offered grass silage showed an increase of 200kg/cow in total milk yield when compared to those cows previously offered zero-grazed grass (Table 3). Although there were no differences in milk quality, the increase in milk production resulted in an increased milk value of £53/cow, which lead to an overall increase of £44/cow in margin over feed and forage cost per cow, when compared to animals previously offered zero-grazed grass. When taken over the entire study, there were minimal differences in both feed costs (£593 vs £598) and margin over feed and forage costs (£984 vs £949) for silage and zero-grazed grass fed cows, respectively.

Table 1. Grass quality throughout the first period of the study

	DM (%)	ADF (%)	CP (%)	WSC (%)	ME (MJ/kg DM)
September	13.9	30.2	14.1	14.5	11.1
October	14.5	29.2	16.4	13.7	11.3
November	11.3	30.3	18.1	7.9	11.1
Average	13.2	29.9	16.2	12.0	11.1

Table 2. Cow performance during the two periods of the study

	Autumn (48 days)		Winter (119 days)	
	S:S	**ZG:S**	**S:S**	**ZG:S**
Total intake (kg DM/cow/day)	18.7	20.5	22.8	21.9
Milk yield (kg/cow/day)	34.1	35.5	36.0	34.6
Milk fat-plus-protein yield (kg/cow/day)	2.72	2.81	2.61	2.61
Milk energy output (MJ/cow/day)	118	122	115	114
Live weight (kg)	629	648	619	639
Body condition score	2.6	2.6	2.5	2.5

S:S = Silage throughout autumn and winter periods,
ZG:S = Zero-grazing in autumn period, silage in winter period

Table 3. Cash cost comparison of dairy cows over the autumn and winter periods

	Autumn (48 days)		Winter (119 days)	
	S:S	**ZG:S**	**S:S**	**ZG:S**
Forage intake (kg DM)	440	672	1421	1321
Concentrate intake (kg DM)	457	409	1288	1285
Milk yield (kg/cow)	1384	1472	4455	4255
Milk value (£)	374	398	1203	1150
Feed cost (£)	151	166	442	433
Margin over feed and forage (£/cow)	223	232	761	717

*Cash cost assumptions = concentrate cost = £243/t DM, base milk price = 27ppl. S:S = Silage throughout autumn and winter periods, ZG:S = Zero-grazing in autumn period, silage in winter period

Farming guidance

Providing cows with autumn zero-grazed grass offers the potential to increase dry matter intake, milk production and milk protein content throughout September and October when conventional full-time grazing could be challenging. However, over the course of the entire study (September – February) there was little difference in overall feed costs and margin over feed and forage per cow. As a result farmers considering whether to zero-graze in autumn as an alternative to grass silage feeding should make their decisions after assessing the actual and target grass supply on the grazing platform, and forage stocks for the coming winter.

Footnote: This study was funded by AgriSearch and the Department of Agriculture, Environment and Rural Affairs (DAERA).

PERFORMANCE OF COWS WITHIN GRAZING, PARTIAL GRAZING AND FULLY HOUSED SYSTEMS, AT A FIXED CONCENTRATE FEED LEVEL

Conrad Ferris and Andrew Dale

Key message

- At a fixed concentrate intake, similar milk yields can be achieved when cows are managed on a full-time grazing, day-time grazing or fully housed system.
- Milk fat concentrations will normally be lower with full-time grazing systems.
- The relative performance within each system will be determined by the quality of silage offered, grassland management practices adopted, and weather conditions during the grazing period.
- Feed, labour and machinery costs will be significantly lower with full-time grazing.

Background

In recent years there has been an increasing trend towards less reliance on grazing in dairy systems, with many herds now either part or full-time housed during the summer period. Difficulties in meeting the nutrient requirements of high-yielding cows within grazing systems is one reason normally given for the move away from full-time grazing. Increasing herd size has also contributed to the adoption of 'summer housing', as in some cases the grazing platform accessible from the milking parlour will be insufficient. This can be a particular issue on farms with fragmented land blocks, where walking cows to and from grazing areas has become increasingly difficult due to increasing traffic on many rural roads.

One of the key factors that needs to be considered in adopting a system with increased reliance on housing during the grazing period is the very significant increase in costs, and whether this can be justified in terms of improved cow performance.

Research study details

Sixty-six mid lactation Holstein cows, 22 in their first lactation, were managed on one of three systems from early May to late September:

1. Full-time grazing: Cows grazing both 'day' and 'night'.
2. Day-time grazing: Cows grazing by 'day' (between morning and afternoon milking) and housed at 'night' and offered grass silage.
3. Full-time housing: Cows housed both 'day' and 'night' and offered grass silage.

The silage offered was good quality, with a dry matter of 33%, a crude protein content of 14.3% DM and a D value of 72%. All cows were offered 8.0kg of concentrate per day in-parlour (4kg at each milking), the concentrates offered with each system being designed to supplement the forage offered.

Research findings

The performance of cows on the three treatments are summarised in Table 1. Cows on the full-time grazing treatment had a much higher grass intake (10.5kg DM/day) than those on the day-time grazing treatment (3.0kg DM/day). This was despite the fact that the cows grazing by day-only had a higher post-grazing sward height (6.0 cm) compared to those grazing full-time (5.2 cm). The low grass intake of the day-time grazing cows was reflected in their high silage intakes (9.3kg DM/day), which was only 2.7kg DM/day lower than for cows housed full-time.

All three groups of cows had similar milk yields with similar milk protein content. However, cows on full-time grazing produced milk with a lower fat content, and as a result these cows had a lower fat plus protein yield than those housed full-time or only by night. The lower milk fat content with full-time grazing reflected the lower fibre content of grazed grass compared to grass silage.

An economic analysis was undertaken based on a milk price of 28 pence per litre, a concentrate cost of £250/t, and with grazed grass and grass silage costed at £110 and £140/t DM, respectively. The value of milk produced was 39p per day lower with full-time grazing compared to full-time housing, largely due to the lower fat content of the milk produced. However, the margin over feed costs was similar with the full-time housing treatment and the full-time grazing treatment. In addition to this, the labour and machinery costs also need to be considered.

Whilst labour and machinery costs associated with the different systems will vary greatly from farm to farm, depending on facilities and equipment available, the day-time grazing system will have the highest costs as it incorporates all aspects of both the full-time grazing and housing systems. In addition, previous research has also shown that housed cows are likely to have more health problems than grazing cows.

Table 1 Dairy cow performance when full-time grazed, full-time housed or partially grazed/housed during May to September

	Full-time Grazing	Day-time Grazing	Full-time Housing
Grass dry matter intake (kg/day)	10.5	3.0	0
Silage dry matter intake (kg/day)	0	9.3	12.0
Total forage dry matter intake (kg/day)	10.5	12.3	12.0
Milk yield (litres/day)	26.8	26.4	27.1
Milk fat (%)	3.80	4.32	4.27
Milk protein (%)	3.47	3.44	3.49
Milk fat-plus-protein yield (kg/day)	1.95	2.04	2.12
Final live-weight (kg)	585	621	625
Final condition score	2.4	2.6	2.6
Value of milk produced (£/day: milk @28 ppl)	7.75	7.91	8.14
Margin over feed and forage costs (pence/litre)	4.16	4.04	4.19

Farming guidance

The performance of cows on each of these different management systems will vary between individual farms depending on the silage quality available, grassland management practices and weather conditions during the grazing period. However, the results of this study demonstrate that when concentrate levels are the same, the difference in performance between well managed grazing systems and those involving part or full-time housing over the summer can be very small and are unlikely to compensate for the significant increases in feed, labour and machinery costs associated with housing.

GRAZING INTENSITY FOR HIGH YIELDING COWS

Andrew, Dale, Peter Purcell and Conrad Ferris

Key Messages

- Increasing grazing intensity of high yielding cows improved grass utilisation by up to 9% but reduced milk yield by 2.7kg/cow/day.
- On farms where milk yield per cow is a key objective, a post-grazing residual of 6.1cm ("Normal") represents a target grazing intensity for high yielding cows supplemented with high levels of concentrate.
- Where the land base is limited, improving grass utilisation through increased grazing intensity will results in greater milk output per hectare and a higher margin over feed and forage per hectare.

Background

Managing high yielding cows within grazing systems often presents a challenge in balancing high levels of animal performance whilst maintaining good grass quality and utilisation. Grazing management strategies which provide increased herbage allowances per cow lead to increased grass intakes and higher levels of milk production, however, these often also lead to a reduction in grass utilisation efficiency. In addition, grazed grass alone cannot support the potential milk production of high yielding cows, requiring the use of supplementary concentrates which again can impact on grass utilisation under moderate levels of supplementation. Currently little is known about the relationship between herbage allowance and cow performance when high-yielding cows are offered high levels of concentrates. A study was designed to examine the impact of three different grazing intensities on performance of high yielding dairy cows offered high levels of concentrates and grass utilisation.

Research study details

This study involved 63 Holstein-Friesian dairy cows, 21 in first lactation, and ran from 29 April to 17 September. Cows were an average of 65 days calved with an average milk yield of 36kg/day at the start of the study. Cows were split into 3 groups and allocated to either 'Tight', 'Normal' or 'Lax' grazing intensities. They were managed within a paddock grazing system with the intensities imposed by altering the size of the paddocks being grazed to 0.14, 0.17, and 0.20 hectare for Tight, Normal, and Lax grazing, respectively. Concentrate feed levels were 9kg offered per day to cows and 6kg to heifers. Animal performance along with grass quality and utilisation were monitored throughout the study.

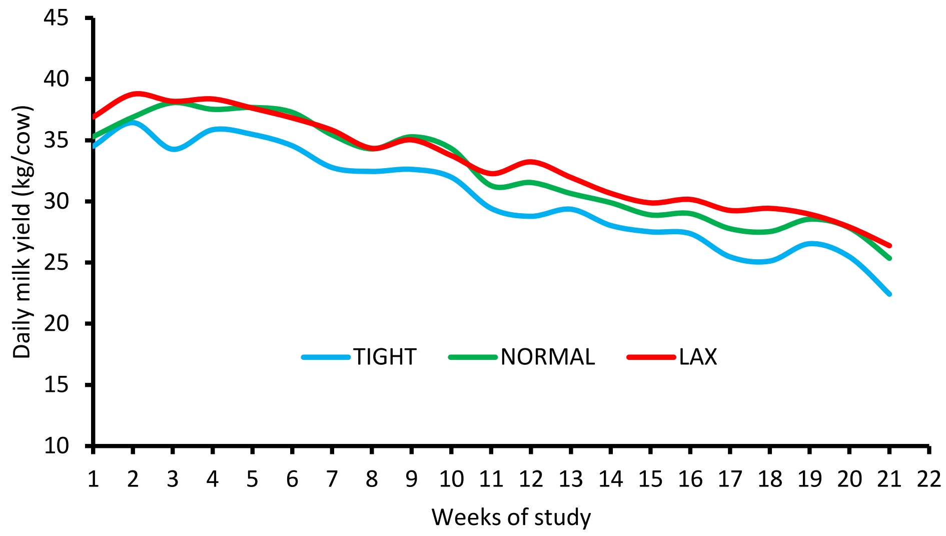
Research findings

Grass intakes were highest with 'Lax' grazing, with cows consuming 1.4 and 1.6kg DM/day more than those on the 'Normal' and 'Tight' grazing, respectively (Table 1). This increase in dry matter intake resulted in an increase in milk production of 2.7kg/day and an increase of 0.21kg/cow/day in milk fat-plus-protein yield from 'Lax' grazing when compared to the 'Tight' grazing management (Table 1). There were minimal differences in milk quality and production between the 'Lax' and 'Normal' grazing. Furthermore, grazing intensity had no effect on either live weight or body condition score at the end of the study (Table 1) (Figure 1).

Table 1 Effect of grazing intensity on cow performance

	Grazing intensity		
	TIGHT	**NORMAL**	**LAX**
Concentrate intake (kg/cow/day)	8.1	8.1	8.1
Grass dry matter intake (kg/cow/day)	8.8	9.0	10.4
Total dry matter intake (kg/cow/day)	15.9	16.1	17.5
Milk yield (kg/cow/day)	30.5	32.2	33.2
Milk fat-plus-protein yield (kg/cow/day)	2.02	2.16	2.23
Live weight at end of study	545	555	561
Body condition score at end of study	2.4	2.3	2.4

Figure 1: Impact of grazing intensity of daily milk yield of grazing dairy cows supplemented with high levels of concentrate



The results show that performance of high yielding cows is reduced within a tight grazing system, even when they are provided with high levels of concentrate. However, grass utilisation efficiency was increased by up to 12 and 19% in a tight grazing system when compared to 'Normal' or 'Lax' systems, respectively (Table 2). The tighter grazing strategy resulted in higher stocking rates (cows/hectare), this increased both total milk output and total solids per hectare when compared with 'normal' and 'Lax' grazing (Table 2).

Table 2 Effect of grazing intensity on grass quality, stocking rate and economic performance

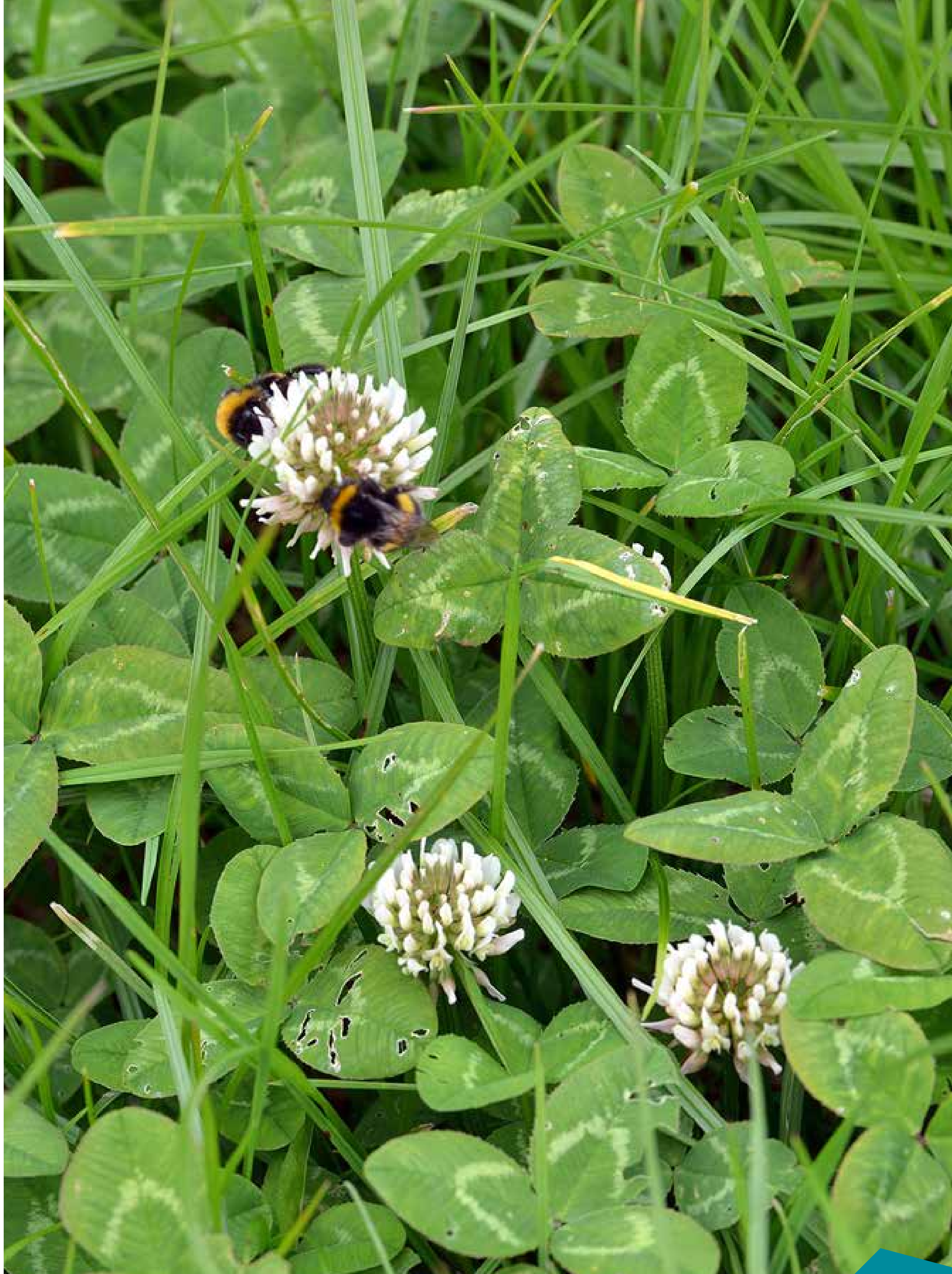
	Grazing intensity		
	TIGHT	**NORMAL**	**LAX**
Post-grazing sward height (cm)	5.2	6.1	6.8
Grass utilisation efficiency (%)	81	69	62
Grass metabolisable energy content (MJ perkg DM)	11.9	11.7	11.7
Grass crude protein content (% DM)	23	22	21
Grazing stocking rate (cows/hectare)	7.8	6.7	5.6
Total milk output per hectare (kg)	33,178	30,229	25,558
Total milk fat plus protein output per hectare (kg)	2,197	1,992	1,738
Margin over feed and forage (£/cow; 142d study)	890	960	1000
Margin over feed and forage (£/ha; 142d study)	6061	5195	4270

At a milk price of 27 pence per litre and a concentrate cost of £250 per tonne, both the margin-over-concentrates and margin over feed and forage were highest with 'lax' grazing and lowest with 'Tight' grazing. However, when considered on a per hectare basis, margin over feed and forage was 17% and 42% higher compared to the 'Normal' and 'Lax' managements.

Application in practice

Even with high levels of concentrate feeding, milk yield per cow was reduced with a 'Tight' grazing strategy. On farms where milk yield per cow is a key objective, a post-grazing residual of around 6cm ("Normal") represents a target grazing intensity for high yielding cows supplemented with high levels of concentrate. However on farms with a limited land base, improving grass utilisation through increased grazing intensity will result in greater milk output per hectare and a higher margin over feed and forage per hectare.

Footnote: This study was co-funded by DAERA and AgriSearch



AFBI PRECISION GRASSLAND PLATFORM

Debbie McConnell and Jessica Pollock

Key messages

- Precision technology has a key role to play in improving our understanding and management of grazing animals and new technology is now being developed for this environment
- To achieve maximum value out of precision technology in grassland it is important to integrate information from different digital sensors
- AFBI are currently developing a Precision Grassland Platform that integrates detailed data from soil, plant and animals to drive meat and milk production from grassland.

Background

With a competitive advantage of highly productive grassland, and significant scope to increase grassland utilisation, Northern Ireland is perfectly placed to drive efficiencies in livestock production systems through better use of forage. Recent AFBI research has shown that improving grass production and grass utilisation by 1 tonne (DM) on dairy farms is worth £334 per hectare per annum (Mayne and Bailey, 2016). Driving milk production from grassland will also buffer farmers against global fluctuations in purchased feedstuffs.

Precision technologies present a unique opportunity to assist farmers in this challenge. Indeed, technology development is expected to result in the greatest step-change we will see in the agricultural industry during this generation, causing fundamental changes in both our understanding and management of agricultural systems. Grazing livestock form part of a complex biological system with high levels of variability, which are difficult to capture. Precision technologies can facilitate measurement and improved understanding of the variability in the 'soil-plant-animal' interface. However, maximum value can only be obtained by expert integration and interpretation of these data.

Much technology development to date for dairy systems has focused on the housed environment, where data is transmitted over short distances in a drier, more controlled environment. However, as battery power extends, software developments improve and transmission ranges increase, new opportunities for incorporating precision technologies into the more challenging environments of open air grazing are now increasingly possible.

The AFBI precision grazing platform

In 2015, AFBI became a member of the Centre for Innovation and Excellence in Livestock (CIEL). This is a consortium of research institutions and industry, working together to improve the competitiveness and sustainability of the UK livestock sectors by supporting new research and innovation for UK farmers. CIEL has received funding from the UK government to invest in agricultural research facilities.

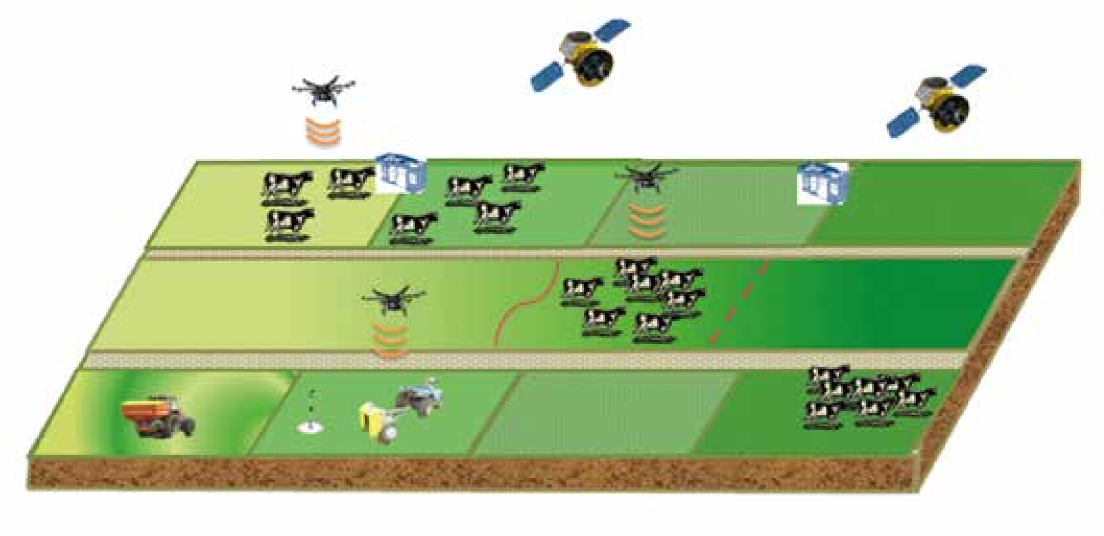
As part of this investment, AFBI are currently building a Precision Grassland Platform at AFBI Hillsborough. This highly instrumented platform will provide a unique research tool to improve our understanding of the grazing environment. The platform, which will be fully in place by summer 2019, will host a range of emerging technologies such as animal location sensors, virtual fencing and drone technology. It will effectively create a 'connected landscape' which will harvest real-time data from the soil, plant and animals. The constant flows of data will be integrated on a large server and that information used in research studies to optimise milk output from grass.

The platform will:

- Contain soil sensors for monitoring temperature, moisture and nutrient content.
- Employ variable rate nutrient application technology to evaluate techniques to improve fertiliser efficiency.
- Collect detailed weather data to evaluate potential grass growing conditions.
- Trial new technologies for non-destructive measurement of grass yield including drones and laser technology.
- Use pedometers, rumination halters and location systems to track animal behaviour and precision allocate grass.
- Employ in-field concentrate feeding and weigh cells to target concentrate supplementation effectively.
- Use a network of 25+ data relay towers to stream real-time data from the platform to make rapid decisions on grassland management and grass allocation.

These facilities will also be integrated with a network of over 50 commercial farmer 'co-researchers'. The key objective will be to evaluate the suitability and the potential benefits that local grassland farmers could gain by adopting some of these new technologies on the home farm.

Schematic of AFBI's Precision Grassland Platform



IMPROVING BODY CONDITION SCORE OF THIN COWS IN LATE LACTATION A CHALLENGING TASK

Conrad Ferris, Andrew Dale and Peter Purcell

Key messages

- Offering a low protein/high starch concentrate in late lactation did not improve the body condition score of thin cows.
- An extended dry period (13 weeks) resulted in a 0.4 unit increase in body condition score, but had no long-term performance benefits.
- Body condition score should be carefully monitored from mid lactation onwards.

Background

Most Holstein cows mobilise body tissue for milk production in early lactation, and replace this body tissue in later lactation. However, if diet quality is poor, or if grazing conditions are difficult, cows may reach late lactation with suboptimal body condition scores. These low body condition cows have an increased risk of health and fertility problems following calving, and an increased risk of being culled.

However, there is little information available on management strategies for low body condition cows in late lactation. One strategy that has been suggested to improve body condition in late lactation involves offering a low protein/high starch concentrate. Alternatively, the use of an extended dry period has also been advocated as a strategy to improve body condition score.

Research undertaken

Sixty-five Holstein-Friesian dairy cows were grazed very tightly in mid/late lactation so as to achieve an average body condition score of 2.25 at 14 weeks pre-calving. Cows were allocated to one of three treatments at this time, as follows:

1. **Normal protein:** From 13 weeks pre-calving until 8 weeks pre-calving, cows on this treatment were offered grass silage plus 5.0kg/day of a 'normal protein' concentrate (20.6% crude protein, 18.2% starch; fresh basis). These cows were then dried-off and offered grass silage without concentrates until calving.
2. **Low-protein:** From 13 weeks pre-calving until 8 weeks pre-calving, cows on this treatment were offered grass silage plus 5.0kg/day of a 'low protein/high starch' concentrate (13.4% crude protein, 25.8% starch; fresh basis). These cows were then dried-off and offered grass silage without concentrates until calving.
3. **Extended dry period:** Cows were dried-off 13 weeks pre-calving and offered grass silage without concentrates until calving.

Following calving, cows on all three treatments were offered a diet of grass silage plus approximately 13kg concentrate/day for 140 days.

Outcomes

The effect of these three treatments from 13 weeks pre-calving until 8 weeks pre-calving; from 8 weeks pre-calving until calving; and for the 140 days post calving are presented in Table 1.

The effects of a low protein diet in late lactation: From 13 weeks pre-calving until 8 weeks pre-calving, cows on the Normal protein treatment were offered a diet with an overall crude protein content of 15.8% (DM basis) while cows on the Reduced protein treatment were offered a diet with an overall crude protein content of 13.7%. Cows on the low protein diet produced less milk (1.2kg/day less milk), but they also had a lower feed intake at this time, and therefore there was no benefit in body condition gain.

Following drying-off, cows on the Normal and Low protein treatments gained a similar amount of body condition (approximately 0.1 units) during their 8 week dry period. Thus over the 13 week pre-calving period, the body condition score of cows on these two treatments improved by 0.2 of a unit. However, cows managed on the Low protein treatment in late lactation continued to have a lower silage intake during the dry period than cows managed on the Normal protein treatment, even though all were offered a common diet.

The treatments imposed during late lactation had no effect on calving difficulty score or on calf birth weight. Following calving, cows on the Low protein treatment in late lactation continued to have a lower intake than those on the Normal protein treatment, and this was reflected in a reduced milk yield. On this basis the use of low protein/high starch concentrates in late lactation cannot be recommended as a management practice to improve body condition.

The effects of an extended dry period: Adopting an extended dry period reduced full lactation milk production by approximately 350kg, although cows on this treatment were also offered 175kg less concentrate. In addition, cows on the Extended dry period treatment gained marginally more body condition from 13 weeks pre-calving until 8 weeks pre-calving, than cows on the other two treatments.

Cows on the Extended dry period treatment tended to gain more body condition during the last 8 weeks of the dry period than cows on either of the other two treatments, and had a body condition score of 2.6 during the week pre-calving. This represents a total gain over the 13 week pre-calving period of 0.4 of a unit of body condition. These results indicate that an extended dry period can be reasonably effective as a means of improving the body condition score of cows in late lactation. However, the difference in condition score disappeared almost immediately after calving, and the extended dry period resulted in no milk yield or milk composition benefits during the subsequent lactation. Thus, while an extended dry period can improve body condition score, this does not necessarily result in increased performance in the subsequent lactation, or compensate for the loss of production in the current lactation.

Conclusions:

Based on the outcomes of this study, offering a low protein/high starch concentrate in late lactation cannot be recommended as a means of improving the body condition score of cows with a low body condition score. This treatment was actually associated with some long term negative effects. The use of an extended dry period (13 weeks) resulted in a 0.4 unit increase in body condition score. In contrast, cows on the other two treatments gained less than 0.2 units of body condition score over the same 13 week period pre calving. However, the extra body condition gained by cows during the extended dry period was lost quickly post calving, and no long-term performance benefits were observed.

Footnote: The full results of this study are now available in Booklet 33 on the AgriSearch website. Study was co-funded by DAERA and AgriSearch through the Research Challenge Fund (RCF).

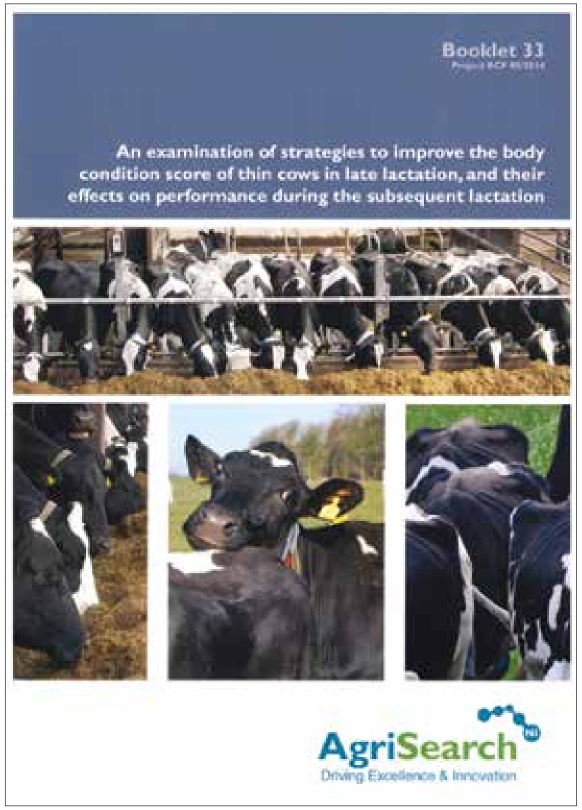


Table 1 Effect of diet protein content in late lactation, and an extended dry period, on cow performance pre calving and post calving

	Normal protein in late lactation	Low protein in late lactation	Extended dry period
Pre-calving (week 13 until week 8)			
Total DM intake (kg/day)	15.4	14.3	10.8
Milk yield (kg/day)	12.6	11.4	0
Milk fat + protein yield (kg/day)	0.97	0.83	0
Condition score at 8 weeks pre-calving	2.33	2.30	2.41
Pre-calving (week 8 until calving)			
Total DM intake (kg/day)	10.8	9.5	10.6
Condition score at calving	2.44	2.42	2.60
Post-calving (Calving until week 19)			
Calf birth weight (kg)	41.4	38.6	41.3
Total DM intake (kg/day)	22.9	21.8	23.1
Milk yield (kg/day)	37.8	35.6	38.4
Milk fat + protein yield (kg/day)	2.78	2.55	2.75
Condition score at end of experiment	2.44	2.45	2.44

CONCENTRATE FEEDING DURING THE DRY PERIOD

BENEFICIAL OR NOT?

Conrad Ferris, Mark Little and Ryan Law

Key messages

- A body condition score of 2.75 at drying off should be the target with higher input systems.
- When cows have a condition score of 2.5 or above at drying off, and are offered good quality silage together with a high quality dry cow mineral supplement, offering concentrates during the dry period is unlikely to result in milk yield, health or fertility benefits.
- It is difficult to get thin dry cows to gain body condition during an 8 week dry period, even if concentrates are offered.
- Very thin cows have an increased risk of being culled in early lactation, and so need a special management focus in late lactation and during the dry period.
- Dry cows require good quality silage!

Background

The period around calving (the transition period) is one of the most important periods in relation to overall cow productivity. This period can be highly stressful for the dairy cow given the stress of calving, an increased risk of injury and uterine infection and large changes in diet. In addition, the cow's immune system becomes suppressed at this time making her more susceptible to infection.

Nutritional and management strategies during the dry period should be targeted at preparing the dairy cow to achieve high milk yields and high fertility levels during the following lactation, whilst minimising the risk of metabolic and infectious diseases. While concentrate feeding during the dry period is often recommended as a strategy to improve body condition of cows prior to calving and to 'prepare the rumen' to better cope with concentrate rich diets offered in early lactation, the scientific evidence to support this is limited.

Research study details

In a series of studies the effect of concentrate feeding during the dry period has been examined. In the first study, cows were offered either Silage only, or Silage plus 3.0kg concentrate during the entire dry period. Offering concentrates during the dry period increased total DM intake, and cows on this treatment gained more live-weight and body condition during the dry period than those on the Silage only treatment. However, following calving the cows that were offered concentrates during the dry period lost more live weight and body condition than those on the Silage only treatment. While neither milk yield nor milk protein content was affected by concentrate feeding during the dry period, cows offered concentrates tended to produce milk with a higher fat content (Table 1). This is likely due to the mobilization of body fat with cows on this treatment. Cows offered concentrates also had improved immunity during the first week post calving, although this effect was small, and no difference was observed in the incidence of disease between the cows on the two treatments.

Table 1 Effect of offering concentrates during the dry period on milk production during the subsequent lactation.

	Dry cow diets	
	Silage only	Silage plus concentrates for the entire dry period
Milk yield (kg per cow per day)	38.8	39.4
Milk fat (%)	4.43	4.65
Milk protein (%)	3.21	3.25
Milk fat plus protein yield (kg per cow per day)	3.0	3.1

In the second study cows offered a 'silage only' diet throughout the entire dry period were compared with those offered 'silage plus 4.5kg concentrates' for the last 4 weeks of the dry period only. Again, offering concentrates increased total DM intake during the dry period, but resulted in only a 0.1 unit increase in body condition score compared to cows offered silage only. Cow performance post calving (Table 2) was unaffected by concentrate supplementation during the dry period.

Table 2 Effect of offering concentrates during the dry period on milk production during the subsequent lactation.

	Dry cow diets	
	Silage only	Silage plus concentrates in last 4 weeks of dry period
Milk yield (kg per cow per day)	33.2	33.5
Milk fat (%)	4.46	4.42
Milk protein (%)	3.28	3.31
Milk fat plus protein yield (kg per cow per day)	2.54	2.57

The results of these two studies support the findings of the third study which was conducted on 10 commercial farms and involved over 1000 cows. Dry period treatments were as follows: 1) Concentrates for the full 8 weeks, 2) Concentrates for the final 3 weeks, 3) No concentrates during the dry period.

Cows with a moderate or high condition score at drying off (2.75 or higher) had lower intakes post-calving. They lost more body condition in the dry period and during the first 12 weeks of lactation than those with a low (2.5 or less) condition score (Figure 1). While fat plus protein yield post-calving was unaffected by condition score at drying off, fertility of thinner cows was marginally improved. However, none of the health parameters examined within this study were affected by condition score. For cows managed on high input systems, these results support the recommendation of a target condition score at drying off of 2.75.

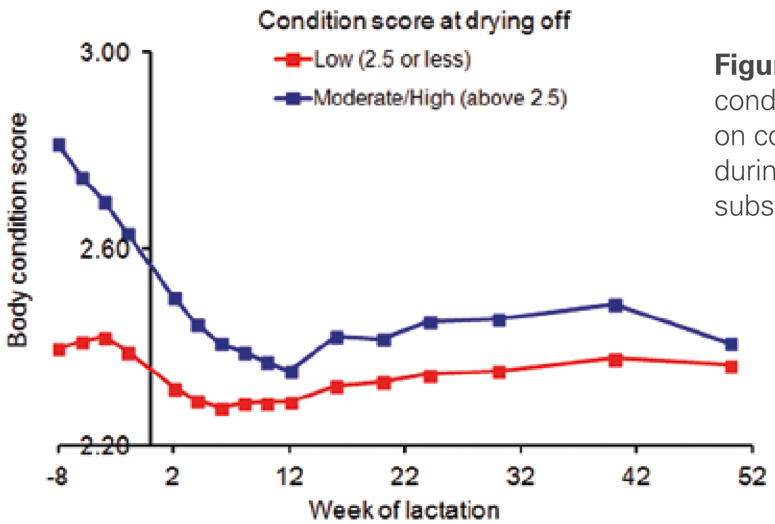


Figure 1 The effect of condition score at drying off on condition score change during the dry period and subsequent lactation

Cows offered no concentrates during the dry period lost slightly more body condition during this period than those offered concentrates. However, this effect was extremely small and was of no practical importance (Figure 2). In addition, offering concentrates during the dry period had no effect on body condition score after calving. These results demonstrate that when good quality silage is offered, it is extremely difficult to get cows to gain body condition during the dry period, even if concentrates are offered throughout the entire dry period. This highlights an important management strategy, namely that cows should be dried off at the target condition score for calving. In addition, offering concentrates during the dry period along with good quality silage had no effect on milk production or milk quality during the subsequent lactation (Table 1). Concentrate feeding during the dry period had no effect on either calf birth weight, fertility performance or cow health during the subsequent lactation.

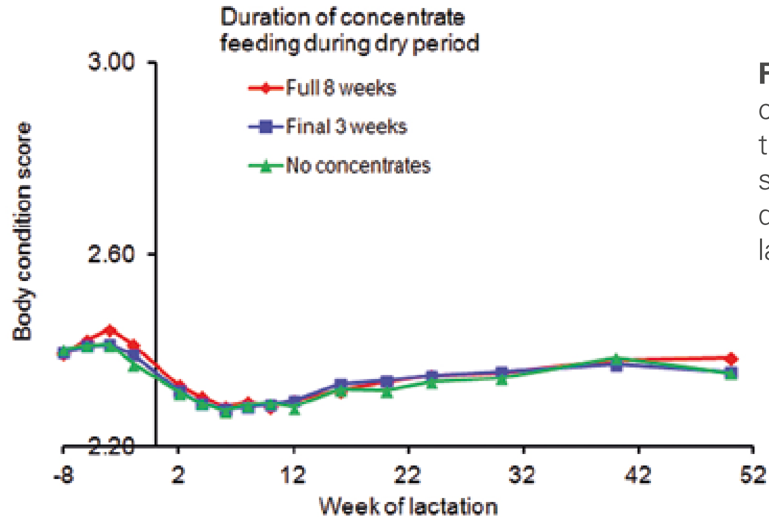


Figure 2 The effect of concentrate feeding during the dry period on condition score change during the dry period and subsequent lactation

Table 1 Effect of concentrate feeding during the dry period on average milk production during the first 10 months post calving (for cows with a condition score of 2.5 or less at drying off)

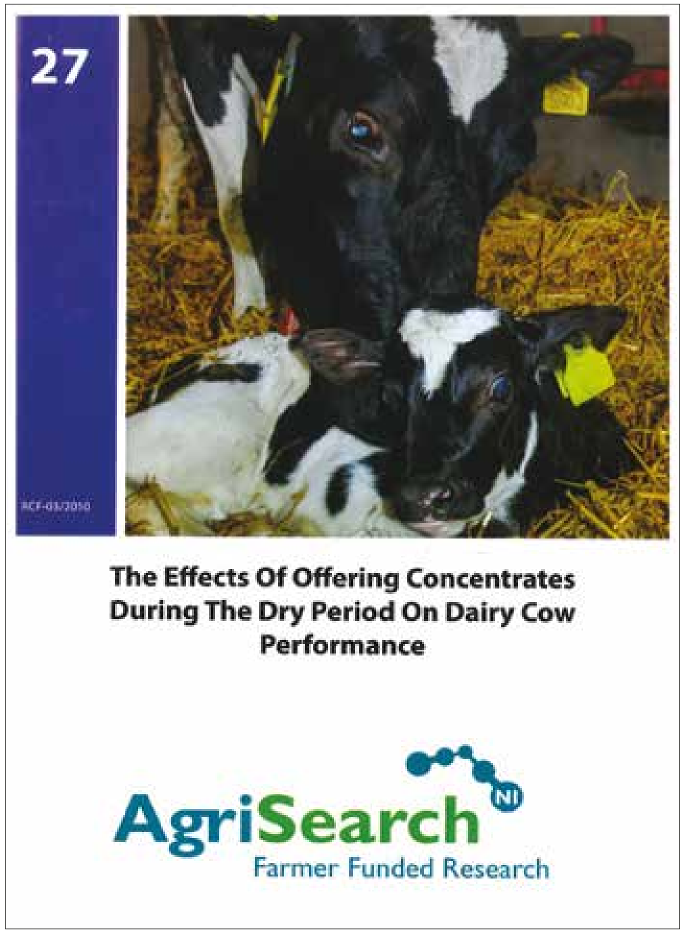
	Duration of concentrate feeding during the dry period		
	Full 8 weeks	Final 3 weeks	No concentrates
Milk yield (kg/day)	26.9	26.8	26.7
Milk fat (%)	4.13	4.08	4.09
Milk protein (%)	3.30	3.32	3.31
Calf birth weight (kg)	43.7	43.6	43.4
Overall conception rate (%)	77.8	78.0	81.0

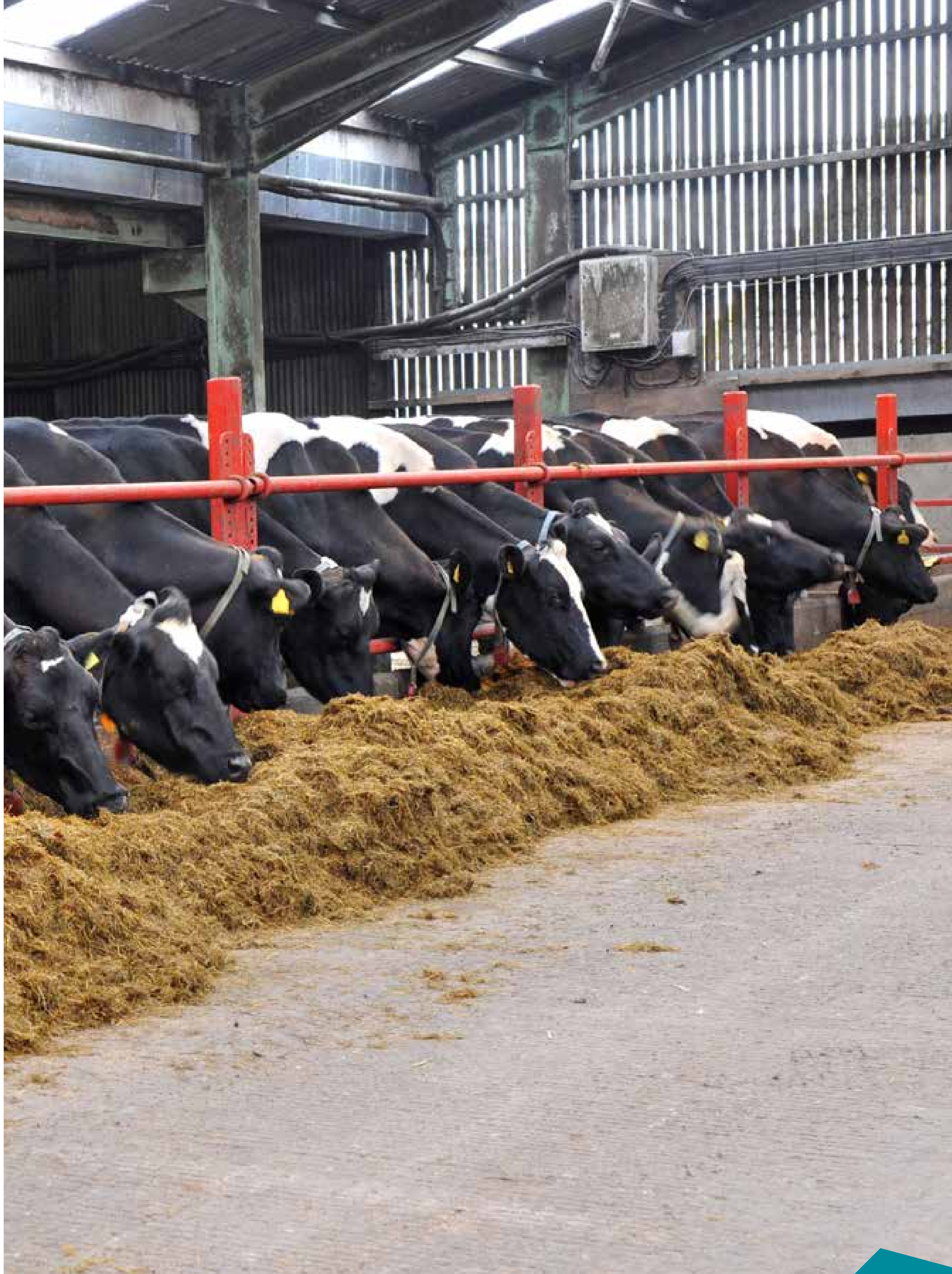
Approximately 30% of cows that were culled during the experiment were culled during the first 60 days of lactation. This highlights the ‘challenges’ that cows face during early lactation. In addition, thin cows (condition score of 2.25 or less) that were not offered concentrate during the dry period had an increased risk of being culled during the first 60 days post calving.

Farming guidance

Thin cows which received no concentrates during the dry period had an increased risk of being culled during the first 60 days of lactation, and as such these cows require a special management focus. However, in general offering concentrates during the dry period has little effect on body condition score pre-calving or cow performance post calving. If moderate to good quality silage is offered during the dry period, there is unlikely to be an economic response to concentrate feeding at this time.

Footnote: Full results of this experiment are now available in a Booklet Number 27 which can be downloaded from the AgriSearch website. Studies were co-funded by AgriSearch and DAERA.





OPTIMUM CONCENTRATE BUILD-UP STRATEGIES IN EARLY LACTATION?

Conrad Ferris, Andrew Dale and Ryan Law

Key messages

- Increasing concentrate feed levels too rapidly in early lactation can cause rumen upset
- Adopting a 'delayed' concentrate build up strategy increased forage intake in early lactation and improved rumen function, but resulted in no long term benefits in milk production, or cow fertility.
- Provided high quality forage is available, a 'delayed' concentrate build up is likely to be beneficial on farms with significant rumen health issues in early lactation.
- A 'moderate' build-up approach based on achieving target concentrate intakes by day-21 post-calving appears to be optimum.

Background

Milk yield increases rapidly in the weeks following calving, and in many cases higher yielding cows are unable to consume enough feed to meet their nutrient requirements. As a result, cows frequently enter a prolonged period of negative energy balance in early lactation. Negative energy balance is reflected in a loss of body condition, an increased risk of metabolic disorders, reduced immunity, and a decline in 'functional traits' such as health and fertility. The vast majority of production diseases occur in early lactation, before cows reach their maximum milk yield.

In an attempt to keep pace with this rapid increase in milk production in early lactation, the quantity of concentrate offered may increase rapidly following calving. However, with the strong drive towards increased milk yield in today's Holstein dairy cow, feeding more concentrates at this time may actually promote milk production, and further increase negative energy balance. In addition, these concentrate rich diets may cause digestive upsets, including sub-acute rumen acidosis (SARA), or in extreme cases, rumen acidosis. It was hypothesised that the adoption of a delayed or slower concentrate build-up strategy would slow the rate of increase in milk production in early lactation, stimulate forage intake, and promote improved rumen function.

Research study details

The first study involved two early lactation concentrate build-up strategies, Immediate and Delayed. From calving onwards, cows on both strategies were offered a basal diet (approximately 15% crude protein and 16% starch) containing forage plus approximately 6.0kg concentrate per day. With the Immediate strategy, a further 7.0kg concentrate was introduced into the diet over the first 10 days of lactation, to give a total concentrate intake of approximately 13kg/cow/day. However, with the Delayed strategy additional concentrate was not offered until day-21 post-calving, at which stage concentrates were built-up over a 14-day period, with cows receiving their full concentrate allowance (13kg/day) by day-35 post-calving.

Cows on the Delayed strategy had a higher forage intake in early lactation (during the period before the additional concentrates were offered), and continued to maintain this higher forage intake throughout the entire study (Figure 1). As a result, cows on this strategy had a lower incidence of rumen health problems than those on the Immediate strategy. However, total DM intake was not affected by treatment. Cows on the Delayed strategy also produced less milk during weeks 3 - 7 post calving than those on the Immediate strategy (Figure 2), however neither total milk yield nor milk composition during the study was affected by concentrate build-up strategy. Cows on the Delayed strategy returned to positive energy balance earlier (week-7 post calving) than those on the Immediate strategy (week-19 post calving). The results of this study clearly demonstrate that a delayed build-up of concentrates in early lactation, combined with a lower protein diet, can result in improved rumen health and higher forage intakes, although excellent quality silage is necessary to allow concentrate build up to be delayed.

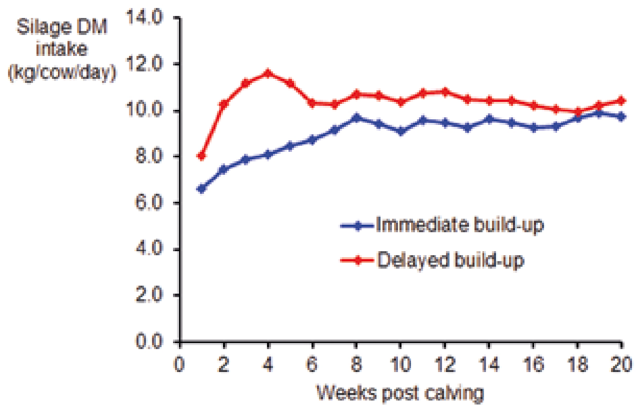


Figure 1 The effect of adopting either an Immediate or Delayed concentrate build up strategy in early lactation on silage DM intake over the first 20 weeks post calving

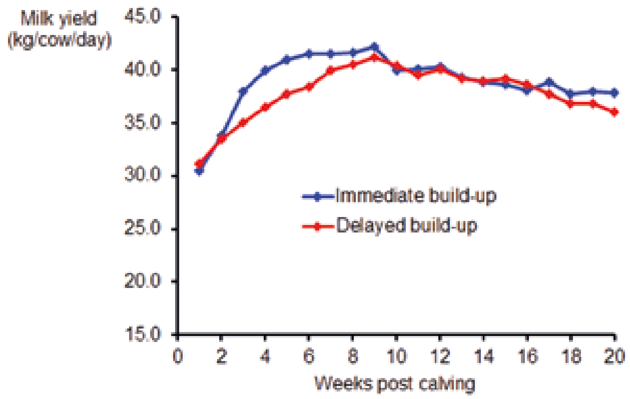


Figure 2 The effect of adopting either an Immediate or Delayed concentrate build up strategy in early lactation on milk yield over the first 20 weeks post calving

This work was repeated in a second study on five local dairy farms to examine the effects on fertility and health. Concentrate build-up strategy had no effect on 305-day milk yield or milk quality (Table 1). Cows on the Delayed treatment had increased conception rate to first service, and a reduced incidence of fertility related health issues (cows not cycling, needing washed-out etc) in the first month of lactation. However, treatment had no effect on conception to first plus second service, or on calving interval. However, cows on the Delayed strategy had an increased incidence of mastitis, although the reason for this is unclear. Concentrate build up strategy had no effect on culling rates during the experiment.

Table 1 Effect of adopting either an Immediate or Delayed concentrate build-up strategy in early lactation on cow performance over the full lactation: conducted on 5 local dairy farms)

	Concentrate build-up strategy	
	Immediate	Delayed
Milk yield (kg/cow)	10,069	9,914
Milk fat (%)	3.93	3.94
Milk protein (%)	3.20	3.21
Conception to first service (%)	23	32
Conception to first and second service (%)	47	50
Cows treated for mastitis (%)	12	19
Cows treated for fertility problems by day-30 post-calving (%)	9	4
Cows culled (%)	31	28

A third study involved a comparison of Rapid, Intermediate or Slow concentrate build-up strategies in early lactation. From calving onwards all cows were offered a 'basal' ration comprising good quality grass silage plus 6.0kg of concentrate/day. A second concentrate was then introduced into the diet from calving onwards using either a Rapid (0.8kg/cow/day), Intermediate (0.31kg/cow/day) or Slow (0.19kg/cow/day) concentrate build-up strategy. Cows on each of these treatments were receiving their full concentrate allowance (14kg/cow/day) by day-10, day-26 and day-42 post calving, respectively.

Forage intakes in early lactation were higher with cows on the Intermediate and Slow build-up strategies (Figure 3). Cows on the Slow build-up strategy had a lower milk yield during weeks 3 - 7 of lactation, compared to those on the Rapid build-up strategy (Table 2). However, there was no difference in milk yield from week-8 of lactation onwards. Thus, this study demonstrates that a delay in concentrate build up can slow the rate of increase in milk yield in early lactation with no long term detrimental effect on overall performance. Cows on the Intermediate and Slow build-up strategies had fewer rumen problems than those on the Rapid build-up strategy. Based on the results of this study, a 'moderate' build-up approach based on gradual increase in concentrates over the first 21 days of lactation is recommended.

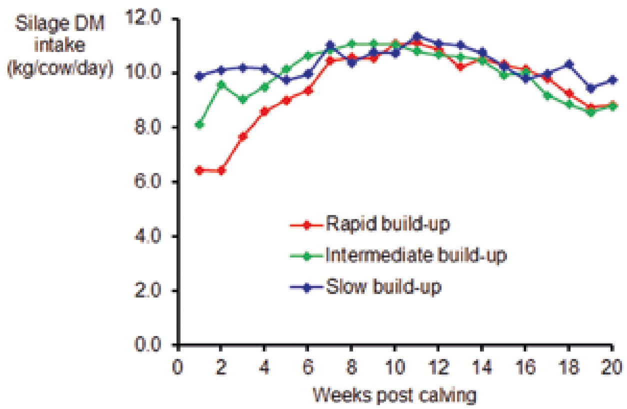


Figure 3 Effect of adopting either a Rapid, Intermediate or Slow concentrate build-up strategy in early lactation on daily forage DM intake

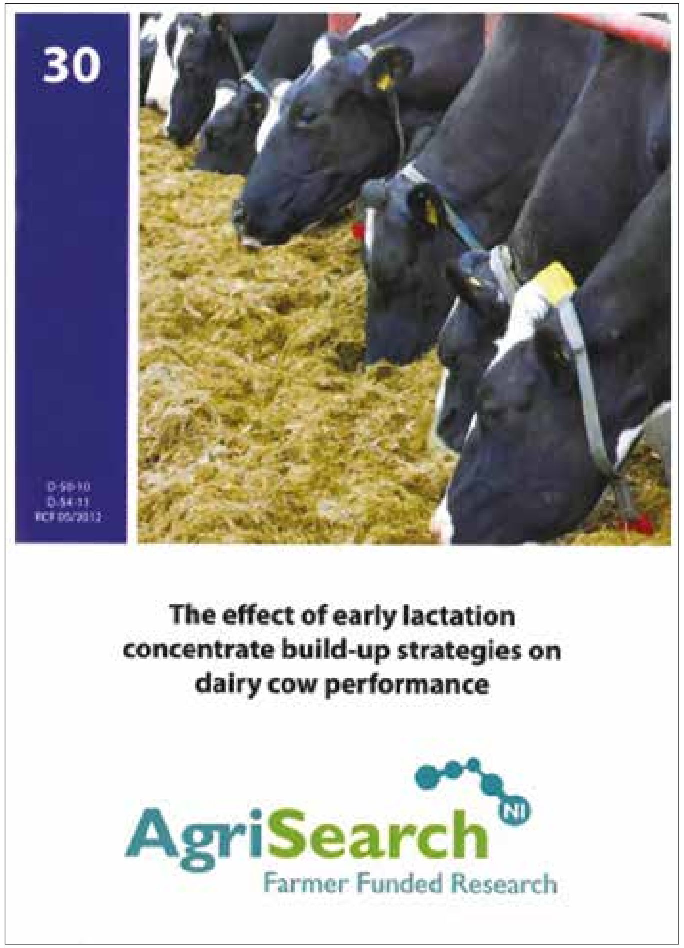
Table 2 The effect of concentrate build-up strategy on daily milk yields and milk composition over the first 150 days of lactation

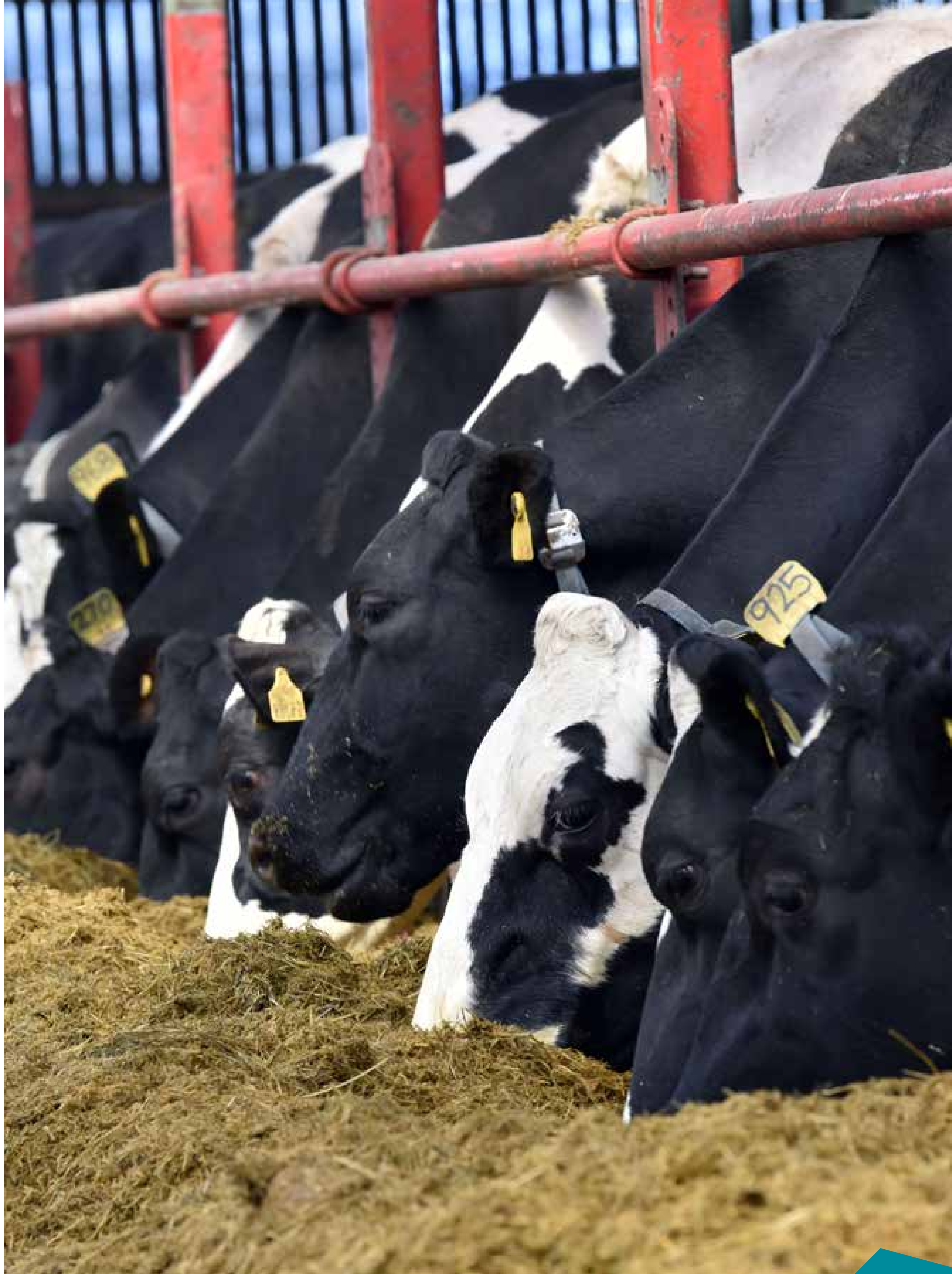
	Concentrate build-up strategy		
	Rapid	Intermediate	Slow
Total DM intake (kg/day)	21.4	21.1	21.6
Milk yield (kg/day)	42.0	41.2	40.1
Milk fat (%)	4.2	4.3	4.2
Milk protein (%)	3.4	3.3	3.3
Milk fat plus protein yield (kg/day)	3.16	3.08	3.00

Farming guidance

Excessive concentrate feeding in early lactation can have a negative effect on rumen function. Delaying concentrate build-up until day-21 post calving resulted in improved rumen health, and higher forage intakes, but no long term benefits in health and fertility. This approach is likely to be beneficial on farms with significant rumen health issues in early lactation, provided high quality forage is available. Based on the overall findings of the research programme, a 'moderate' build-up approach based on achieving target concentrate intakes by day-21 post-calving is a reasonable target.

Footnote: Full details of these experiments are presented in Booklet Number 30 which can be found on the AgriSearch website. Studies were co-funded by DAERA and AgriSearch.





CONCENTRATE ALLOCATION STRATEGIES FOR EARLY LACTATION DAIRY COWS

Mark Little and Conrad Ferris

Key messages

- Cows offered concentrates using a 'complete' diet approach had a flatter lactation curve than those offered concentrates using a Feed-to-yield approach.
- Average cow performance was unaffected by concentrate allocation strategy.
- Similar levels of milk production can be achieved with a simple 'group' feeding system, compared to complex systems that allocate concentrates to individual cows.
- In herds with spread calving patterns, grouping will be required if all concentrates are offered in the form of a complete diet.

Background

Developments in concentrate-feeding technologies allow both in-parlour and out-of-parlour concentrate feeding systems to be directly linked to milking-parlour software, making it possible to automatically adjust concentrate feed levels according to the milk yield of individual cows. These 'feed-to-yield' type systems are increasingly common on local dairy farms.

It is often suggested that offering concentrates on a 'feed-to-yield' basis will increase 'precision' by avoiding under-feeding of higher yielding cows and overfeeding of lower yielding cows. However, while previous research with lower yielding cows (20 – 25 litres/day) found no benefits of a feed-to-yield approach, similar research has not been undertaken with higher yielding cows offered higher levels of concentrates. This study was conducted to compare a 'complete diet' and a 'feed-to-yield' approach to concentrate feeding.

Research study details

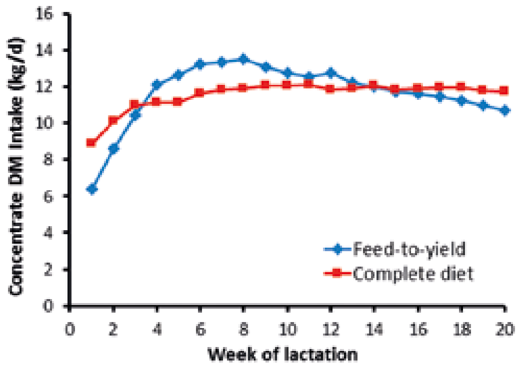
Two different concentrate allocation strategies were applied to 72 Holstein-Friesian cows, as follows:

- *Complete diet:* cows were offered a complete diet comprising 50% grass silage and 50% concentrates (DM basis). This was prepared daily using a mixer wagon.
- *Feed-to-yield:* cows were offered a 'basal diet' which was designed to support the cow's maintenance energy requirements plus 24kg of milk/day (M+24kg). The basal diet was a mixture of grass silage and concentrates (at a rate of 6.0kg per cow per day), and was prepared using a mixer wagon. Additional concentrates were offered on a feed-to-yield basis (at a feed rate of 0.45kg concentrate perkg of milk), to support milk yields in excess of those supported by the basal diet. Concentrate feed levels for each cow were reviewed weekly and adjusted, based on individual cow milk yields during the previous week.

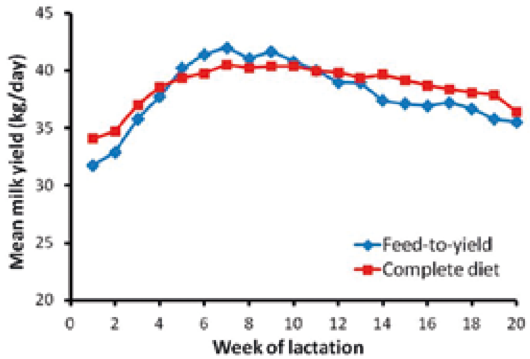
Research findings

While total concentrate intakes with both treatments were similar over the first 20 weeks of lactation (1.8 t), concentrate intakes for cows on the *Complete diet* treatment were relatively 'flat', while concentrate intakes for cows on the *Feed-to-yield* treatment increased over the first eight weeks post-calving, and then declined throughout the remainder of the study period (Figure 1a). Similarly, cows on the Complete diet treatment had a relatively flat lactation curve, while mean milk yield with the Feed-to-yield treatment increased over the first 7 weeks post-calving, and then declined throughout the remainder of the study (Figure 1b).

Figure 1 Effect of concentrate allocation strategy on,



a) concentrate DM intake



b) milk yield over the first 20 weeks of lactation

However, despite the very different lactation curves, mean milk yield (Table 1) was not affected by treatment (the observed difference of 1.3kg milk was not statistical significant). In addition, concentrate feeding system had no effect on either the fat or protein content of the milk produced. Fat plus protein yield was also unaffected by concentrate feeding system. However, while average cow performance was unaffected by treatment, there was a much greater range in both concentrate intakes and milk yields with the Feed-to-yield treatment compared to the Complete diet treatment (Figure 2). For example, with the Feed-to-yield treatment concentrate intakes of individual cows ranged from 9.5 - 18.6kg/day while milk yields ranged from 28 - 56kg/day. In contrast, with the Complete diet treatment concentrate intakes ranged from 11.1 - 15.7kg/day and milk yields ranged from 31 - 53kg/day. In view of the higher level and higher proportion of concentrates in the diets of these higher yielding cows, they are likely to have a greater risk of rumen upset. Indeed, a greater number of cows on the Feed-to-yield treatment were treated for rumen problems. There were no effects on any other health parameters.

Table 1 Effect of concentrate allocation strategy on mean cow performance during the first 20 weeks of lactation

	Feed-to-yield	Complete diet
Concentrate DM intake (kg/day)	11.7	11.5
Silage DM intake (kg/day)	10.3	10.6
Total DM intake (kg/day)	22.2	22.4
Milk yield (kg/day)	38.0	39.3
Fat (%)	4.28	4.29
Protein (%)	3.29	3.24
Fat + protein yield (kg/day)	3.0	3.1
Condition score at end of study	2.4	2.4
Fertility performance		
Days to 1st oestrus	31	31
Conception to 1st service (%)	50	36
Conception to 1st and 2nd service (%)	80	50

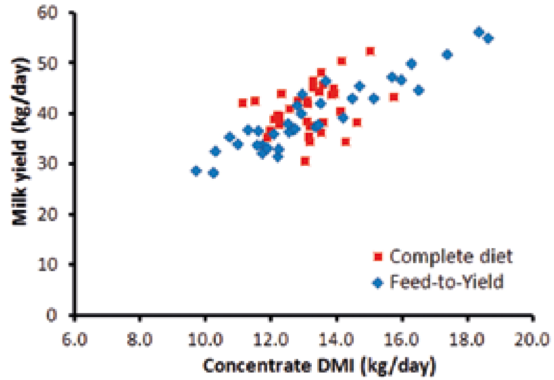


Figure 2 The spread in milk yield and concentrate DM intake with the Complete diet and Feed-to-yield treatments

Concentrate allocation strategy had no effect on the body condition score of the cows at the end of the study. In addition, concentrate allocation strategy had no effect on days to 1st oestrus. However, conception rates to first and second service were lower with the Complete diet treatment. This is surprising as there was no difference in average energy balance between the treatments. In view of the relatively small number of cows involved in this study, the observed difference in conception rate must be treated with caution. Indeed, a second similar study at Hillsborough provided no evidence that fertility was affected by concentrate allocation strategy.

This study provides no evidence that average cow performance was affected when concentrates were offered either on a group basis (Complete diet), or according to the milk yield of individual cows (Feed-to-yield). However, cows on this study calved over a four month period, and consequently all cows were at a relatively similar stage of lactation throughout the study period. In contrast, calving patterns on most farms are more wide spread (often year around), meaning that there are cows in early, mid and late lactation within a single herd. In this scenario, offering a single complete diet would result in late lactation cows being over fed, and concentrates being used inefficiently. Thus grouping of cows into different yield groups is necessary to avoid over-feeding of lower yielding cows, especially those in late lactation. However, research is required to identify optimal regrouping strategies so as to minimise loss of performance at the time of regrouping.

Farming guidance

This study demonstrates that similar levels of milk production can be achieved on farm with a simple ‘group’ feeding system involving a total-mixed-ration, compared to more complex systems involving allocating concentrates to individual cows. Nevertheless, irrespective which strategy is adopted on farm, it is essential that the level of concentrate feeding is appropriate for the quality of the silage on offer, and the milk yield potential of the cows in the herd.

IMPACT OF CONCENTRATE FEED RATE WITHIN A FEED-TO-YIELD SYSTEM

Conrad Ferris and Peter Purcell

Key messages

- Cow performance was similar with 0.35 and 0.45kg feed rates, although margin over feed costs tended to be higher at 0.35kg.
- With high quality silage, a 0.55kg feed rate gave a large increase in concentrate intakes and a reduction in milk fat.
- Milk fat decreased at higher concentrate levels at all feed rates, reducing the value of the milk produced.
- Higher yielding cows in this study had a lower margin-over-feed costs at moderate and low milk prices.
- Feed-to-yield systems should take account of milk composition of individual cows, as well as individual cow milk yields.

Background

The adoption of feeding systems in which concentrates are offered to individual cows according to their milk yield is now common place. The approach most often adopted on local farms involves offering a 'basal diet' of silage and concentrates, which is designed to support the energy requirements of the cow for maintenance, plus a certain milk yield (often referred to as the Maintenance plus, or M+ value). Additional concentrates are then offered to individual cows to support milk yields above those supported by the basal diet.

These additional concentrates are often offered at a feed-rate of 0.45kg of concentrate per litre of milk. This value is based on the assumption that the production of one litre of milk requires approximately 5.2 megajoules (MJ) of metabolisable energy (ME), and that one kilogram of concentrate contains approximately 11.5 MJ of ME. The commonly used feed-rate of '0.45' is then derived by dividing 5.2 by 11.5. In reality however, 0.45 is just a theoretical value, and a range of rates are adopted by nutritionists in practice. This study examined the impact of the 'feed-rate' adopted on cow performance, with three different feed rates examined.

Research study details

Following calving, 75 cows were offered a 'basal' ration comprising silage (70% grass silage, 30% maize silage: DM basis) and concentrates (included in the mix to provide an intake of 6.0kg/cow/day). This basal ration was prepared using a complete diet mixer wagon, and compiled to meet the maintenance-energy requirements of the cows, plus the energy required to produce either 24 (for heifers) or 27 (for cows)kg of milk per day (M+24 or M+27).

In addition, cows were offered further concentrates using out-of-parlour feeders. This was offered on a 'feed-to-yield' basis to support milk yields in excess of those supported by the basal diet, at three rates, of 0.35, 0.45 or 0.55kg of concentrate perkg of milk. The quantity of concentrates offered to each cow through the out-of-parlour feeder was reviewed weekly and adjusted, based on her milk yield during the previous week.

Research findings

Increasing the concentrate feed-rate from 0.35 to 0.45 had little effect on concentrate DM intake (increased from 10.0 to 10.8kg DM/cow/day), and resulted in only a small reduction in silage DM intake (Table 1). Given these relatively small changes in intakes, it is unsurprising that neither milk yield nor milk composition were affected by this increase in feed rate.

However, when concentrate feed rate increased from 0.45 to 0.55, there was an unexpectedly large increase in concentrate intakes, and a further reduction in silage intake. This increase in concentrate intake was accompanied by an increase in milk yield (although not significant), and by a large fall in the fat percentage of the milk produced. The unexpected large increase in concentrate intake at 0.55kg and the fall in milk fat percentage are closely linked. It appears that this higher level feed rate resulted in more concentrates being offered (as expected), which increased milk yields but caused milk fat percentage to fall. Cows responded to this fall by producing more milk, and consequently they were offered more concentrates (as it was a feed-to-yield strategy), resulting in a further reduction in the fat content of the milk produced.

Table 1 Effect of concentrate feed rate on cow performance

(kg conc/kg milk produced above that supported by the basal diet)	0.35	0.45	0.55
Concentrate DM intake (kg/day)	10.0	10.8	12.9
Silage DM intake (kg/day)	11.6	10.9	10.2
Total DM intake (kg/day)	21.5	21.7	23.1
Milk yield (kg/day)	36.9	36.3	38.1
Fat (%)	4.06	4.09	3.81
Protein (%)	3.25	3.33	3.25
Fat + protein yield (kg/day)	2.65	2.68	2.68
Condition score at end of study	2.40	2.46	2.47
Fertility performance			
Days to first oestrus	37	32	26
Conception to 1st and 2nd service (%)	52	41	45

The impact of higher concentrate feed levels on milk fat content is well known, with Figure 1 highlighting that the milk fat percentage decreased with increasing concentrate level, with this effect being particularly dramatic with concentrate levels above 13 - 14kg/cow/day. This fall in milk quality has a substantial effect on the value of each litre of milk produced.

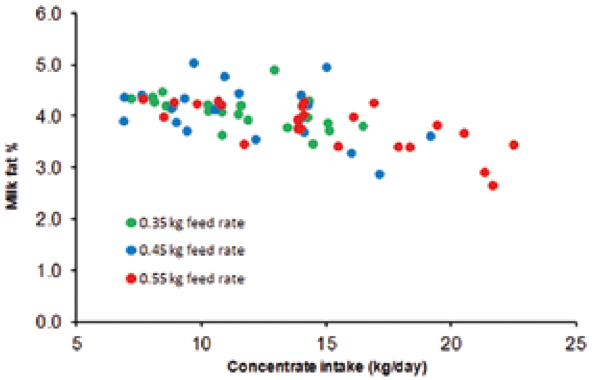


Figure 1 Effect of concentrate intake on milk fat percentage within a Feed-to-yield system

As concentrate feed rate increased, there was a trend for cows to come into oestrus earlier and for more cows to be cycling earlier, but conception rates were unaffected.

Margin-over-feed costs for each individual cow was examined at three different milk prices (18, 26 and 34 pence/litre) with data for all three feed rates having been combined (Figure 2). The results demonstrate that margin-over-feed costs did not continue to increase at high concentrate levels, even though the cows were fed 'to-yield'. This levelling off (or reduction) in margins at the higher concentrate levels is largely due to the decline in milk fat concentrations at these levels, and the associated reduction in the value of each litre of milk produced. The fall in margin was greatest at a milk price of 18 and 26 pence per litre, and calls into question the benefits of continuing to offer high levels of concentrates within a feed-to-yield type system when milk prices are low (provided cow health, welfare and fertility can be maintained at lower concentrate levels).

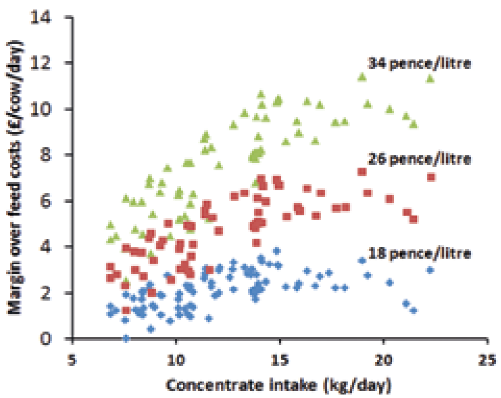


Figure 2 Relationship between concentrate intake and margin-over-feed costs for each individual cow (data combined for the three feed rates treatments, and presented at three different milk prices)

The effect of concentrate feed rate on margin-over-feed costs (£ per cow per day) was also examined at the same three milk prices using the treatment mean data (Table 2). At each milk price, margin per cow per day fell as feed rate increased. The fall in margin was greatest with lower milk prices as the contribution of milk quality bonuses to overall margin is greatest when milk price is low. Based on this analysis, adopting a feed-rate-of 0.35kg concentrate perkg milk would appear to be most profitable. However, good quality silage was offered in this study, and neither fertility performance nor body condition score was influenced by feed rate. This may not be the case with average quality silage, and as such caution is required. Nevertheless, the results demonstrate that when good quality silage is available, concentrate feed rates can be reduced and margins increased.

Table 2 Effect of concentrate feed rate on mean margin-over-feed costs (£ per cow/day) at three different milk prices

(kg concentrate/kg milk produced above that supported by the basal diet)	Concentrate feed rate		
	0.35	**0.45**	**0.55**
Milk Price			
18 pence per litre	2.4	2.2	1.8
26 pence per litre	5.4	5.1	4.9
34 pence per litre	8.3	8.0	8.0

Farming guidance

While cow performance was similar with 0.35 and 0.45kg feed rates, margin over feed costs tended to be higher with the 0.35kg feed rate treatment. This demonstrates that when good quality silage is available, concentrate feed rates can be reduced and margins increased. Milk fat decreased at higher concentrate levels with all feed rates, reducing the value of each litre of milk produced. Feed-to-yield systems should take account of milk composition of individual cows, as well as individual cow milk yields.

UTILISING FIELD BEANS IN DAIRY COW DIETS

David Johnston and Conrad Ferris

Key messages

- Field beans can partially replace conventional protein sources in dairy cow diets. Most of the evidence suggests that inclusion levels up to 3.5kg per cow per day will have no effect on performance.
- At an inclusion level of approximately 4.5kg field beans per cow per day, cow performance was unaffected in one study, but reduced in another. Consequently caution is required at these higher inclusion levels.
- Cow performance was unaffected when field beans were offered either dry and milled, or moist and treated with propionic acid.

Background

As the UK livestock sector has expanded and intensified, the demand for concentrate feeds has increased. This increase in concentrate use has led to an increased demand for quality 'protein' ingredients such as soya-bean meal. However, many protein ingredients are imported from countries outside the European Union (EU), and this has left the dairy sector vulnerable to instability of supply, price volatility, and the limited availability of non-genetically modified protein sources. For these reasons there is increasing interest in the use of locally-grown protein crops.

Field bean (Vicia Faba) is a grain legume of particular interest locally, with yields of 5.5 - 8.5 t/ha reported in Ireland. While the crude protein content of field beans is lower (30% DM basis) than that of soya-bean meal (55% DM basis), field beans have a much higher starch content, 40% of DM compared to 5-7% of DM for soya. However, there is limited information on the animal performance responses when different levels of field beans are included in dairy cow diets. In addition, the use of field beans in dairy cow rations is often restricted due to concerns about 'anti-nutritional factors' which can reduce intakes and performance. A series of studies have examined the use of locally grown field beans in dairy cow diets.

Research study details

In an initial study, sixty mid-lactation dairy cows were offered grass silage supplemented with one of four concentrates types (10.0kg per day) through an out-of-parlour feeder. The concentrates contained either 0%, 16%, 32% or 48% field beans (representing intakes of beans of 0, 1.6, 3.2 or 4.8kg per cow each day). In the diet containing 48% field beans, the beans replaced approximately 75% of the soya-bean meal and 50% of the rape-seed meal. All four concentrates had the same crude protein and starch content (19.3% and 29.5% on a fresh basis, respectively), and a similar metabolisable energy content. The beans (variety Fuego) were grown on a local farm and dried to 16% moisture content, before being milled and incorporated into the concentrates.

In a second study involving 70 freshly calved dairy cows, field beans were included in the concentrates at one of three levels, namely zero, 37% or 74% of the concentrate (actual intakes of field beans of 0, 4.4 and 9.0kg/cow/day). With the 74% inclusion treatment the field beans replaced all of the soya-bean meal and rapeseed meal within the concentrates.

Research study findings

The results of the first study clearly demonstrated that cows were able to consume up to 4.8kg beans per day with no negative effect on any measure of cow performance, although there was a trend for milk protein to fall at the highest field bean inclusion (Table 1). This study indicates that field beans can be included in dairy cow diets at higher levels than previously recommended without having any detrimental effects.

Table 1 Effects of field bean inclusion level in the diet on average cow performance.

	Intake of field beans (kg/day)			
	0	1.6	3.2	4.8
Silage DM intake (kg/day)	12.8	12.9	13.1	12.7
Total DM intake (kg/day)	21.7	21.9	21.8	21.5
Milk yield (kg/day)	28.0	29.0	27.4	28.0
Milk fat (%)	4.35	4.46	4.51	4.45
Milk protein (%)	3.49	3.52	3.49	3.41
Milk fat + protein yield (kg/day)	2.05	2.23	2.16	2.16
Average body condition score	2.44	2.44	2.43	2.43

In the second study, including field beans in the diet of freshly calved dairy cows had no effect on total DM intake or milk yield (Table 2). However, both milk fat and milk protein content were reduced at the highest field bean content (9.0kg/cow/day), while milk fat plus protein yield was reduced with at both 4.0 and 9.0kg/cow/day. This response is different to that in the first study, where fat plus protein yield was unaffected by a field bean inclusion of 4.8kg/day and at present the reason for this difference is unclear

The cost of beans varies considerably from year to year, and to some extent mirrors the change in costs of other protein ingredients. However, assuming costs for soya bean meal and field beans are approximately £300 and £150/t, respectively, margin-over-feed-costs (per cow per day) in the first study would increase from £4.90 with no field beans fed, to £5.20 with 48% field bean use. This represents a potential improvement in margin-over-feed-costs of £5,400 for a 100 cow herd over a typical 180 day winter feeding period. However, the economics of cow performance in the second study, will be much less favourable in view of the reduction in cow performance.

Table 2 Effects of field bean inclusion level in the diet on average cow performance

	Intake of field beans (kg/day)		
	0	4.4	9.0
Silage DM intake (kg/day)	9.7	9.6	9.8
Total DM intake (kg/day)	21.9	21.6	22.1
Milk yield (kg/day)	35.7	33.2	33.9
Milk fat (%)	4.28	4.25	4.13
Milk protein (%)	3.38	3.36	3.22
Milk fat + protein yield (kg/day)	2.71	2.49	2.47
Average body condition score	2.49	2.53	2.51

While both studies examined the use of dried field beans, there is also interest in the use of moist preservation techniques. This option was also examined by comparing three different ways of treating the beans post-harvest,

i) moist preservation of field beans using propionic acid (20 litres/t)

ii) dried field beans which were coarsely milled

iii) dried field beans which were finely milled.

Actual intakes of field beans were approximately 3.5kg/day with each treatment and there were no differences in any aspect of cow performance (Table 3). This demonstrates that on-farm moist preservation techniques can be successfully adopted with field beans.

Table 3 Effects of post-harvest treatment of field beans on cow performance

	Post-harvest treatment		
	Propionic acid treated	Dried, coarsely rolled	Dried, finely rolled
Silage DM intake (kg/day)	13.4	13.0	13.2
Total DMI (kg/day)	22.3	22.6	22.9
Milk yield (kg/day)	32.0	33.5	33.3
Milk fat (g/kg)	42.2	41.9	41.5
Milk protein (g/kg)	33.9	33.7	33.9
Milk fat + protein yield (kg/day)	2.33	2.50	2.47

Farming guidance

Field beans can partially replace soya bean meal and rape seed meal in dairy cow diets. While cow performance was unaffected by feeding approximately 4.5kg/day in the first study, it is unclear why the fat plus protein yield was reduced at a similar inclusion level in the second study. This loss in performance may be acceptable if significant savings are made in the cost of the concentrates offered. However, given the uncertainty about what is driving these responses, it is recommended that maximum inclusion levels should, for the present, not exceed 3.5 - 4.0kg/day. Furthermore, the means of processing field beans either by propionic acid treatment or by drying and coarsely rolling or finely milling is not a critical factor, as feeding beans from all three methods have been capable of supporting the same animal performance.

Field beans growing on a local farm, and beans ready for harvest

THE PERFORMANCE OF JERSEY CROSSBRED COWS ACROSS A RANGE OF MANAGEMENT SYSTEMS

Conrad Ferris

Key messages

- Jersey crossbred cows under low and moderate concentrate input grassland based systems
  - produced similar yields of fat plus protein as Holstein cows
  - had improved health, fertility and survival
  - had a net profit which was £39/cow/year higher than for the Holstein cows
- When offered a high concentrate diet Jersey crossbred cows
  - had a lower milk yield response than Holstein cows
  - partitioned a greater proportion of the concentrate energy to body tissue

Background

Historical genetic selection programmes within the Holstein breed focused mainly on milk production, with less emphasis on functional traits. The subsequent decline in these functional traits within the Holstein breed, especially fertility and health, has now been well documented. Crossbreeding has been suggested as one option by which some of these problems may be overcome. Potential benefits of crossbreeding include the introduction of desirable traits from another breed, the positive effects of hybrid vigour, and a reduction in the negative effects of inbreeding. The performance of Jersey crossbred cows has been examined in a number of studies.

Research details and findings

In an initial study, Jersey x Holstein crossbred cows were compared with pure Holstein cows over a three year period. These cows were managed on three different milk production systems, with concentrate levels within these systems approximately 500, 1000 and 1600kg per cow per year.

Average cow performance across the three systems is presented in Table 1. Over the three years of the experiment the Holstein cows produced approximately 600kg more milk/lactation than the Jersey crossbred cows. However the crossbred cows produced milk with a significantly higher fat and protein content, and the overall outcome was that fat plus protein yield did not differ between breeds. The similar fat plus protein yield reflects the fact that intakes of the two breeds did not differ, even though the Holstein cows were 45kg heavier than the crossbred cows. The crossbred cows tended to have a lower somatic cell count than the Holstein cows, with this reflected in 29% of Holstein cows having at least one incidence of mastitis per lactation, compared to 16% of the crossbred cows. However, perhaps the most striking observation with the crossbred cows in this study was their significantly higher level of fertility. The crossbred cows exhibited signs of heat much earlier than the Holstein cows, had higher conception rates to both first and second service, while a greater proportion of crossbred cows were in calf after the first 12 weeks of the breeding season.

Table 1 Milk production and fertility performance of Holstein and Jersey x Holstein crossbred cows in a three year study at AFBI Hillsborough

	Holstein	Jersey x Holstein crossbreds
Production		
Lactation milk yield (kg)	6282	5627
Fat %	4.20	4.78
Protein %	3.30	3.59
Lactation fat + protein yield (kg)	467	471
SCC (000/ml)	218	173
Average live weight (kg)	515	470
Average condition score	2.3	2.5
Fertility		
Days to 1st observed heat	50	42
Conception to 1st AI (%)	35	58
Conception to 1st and 2nd AI (%)	52	81
Pregnancy rate at 12 weeks (%)	73	89

In a further study, the performance of Holstein and Jersey crossbred cows were compared within a moderate input grazing system (1.2 t concentrate/lactation) and a high concentrate input Year-round housing system (3.3 t concentrate/lactation).

While crossbred cows on the low input grazing system produced 310kg less milk than the Holstein cows (Table 2), fat + protein yield was unaffected by cow breed, as recorded in the previous study. However, when managed on the high input Year-round housing system, the Holstein cows produced 1615kg more milk than the crossbred cows. In addition, even when the improved milk composition of the crossbred cows was taken into account, the yield of milk solids was still higher (10%) with the Holstein cows. Thus, the Jersey crossbred cows did not have the genetic potential to produce the same milk yield response as Holsteins to the higher level of concentrates, and began to partition some of the additional concentrate energy to body tissue.

Table 2 Milk production performance of Holstein and Jersey crossbred cows managed on two different systems

	Moderate input grazing		High input Year-round calving	
	Holstein	Jersey crossbred	Holstein	Jersey crossbred
Lactation milk yield (kg)	6274	5964	9053	7438
Fat %	4.35	4.68	4.34	4.83
Protein %	3.36	3.60	3.40	3.68
Lactation fat + protein yield (kg/lactation)	483	493	697	631

A third study was conducted on 11 Northern Ireland dairy farms and involved 192 Holstein and 189 Jersey crossbred dairy cows, monitored for four full lactations. While calving difficulty did not differ between breeds, the incidence of stillbirths was 12% for Holstein cows and 8% for Jersey crossbred cows when calving for the first time (Figure 1). The incidence of stillbirths was much smaller for both breeds when calving for the second time.

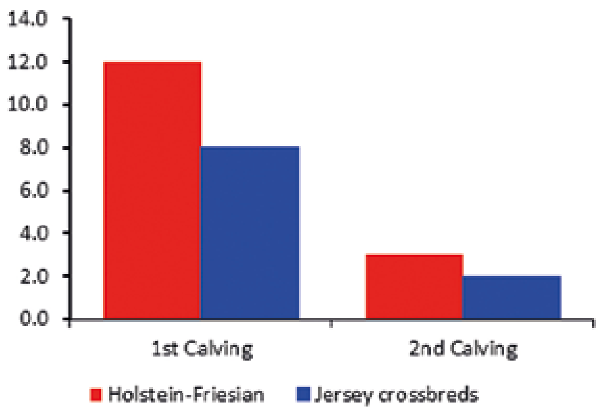


Figure 1 Effect of cow breed on the percentage of calves born dead at the first and second calving (Experiment 3)

Across lactations 1 – 4, average milk yields were 6900 and 6130 litres for the Holstein and Jersey crossbred cows, respectively (Table 3). However, as in the first study, the Jersey crossbred cows produced milk with a much higher fat and milk protein content than the Holstein cows, and the overall effect was that mean fat plus protein yield did not differ between breeds. In addition, crossbred cows had a higher survivability than Holstein cows, with 48% of Jersey crossbred cows surviving until the end of the fourth lactation, compared to 39% of Holstein cows. While cows were culled for many reasons, infertility was the primary reason, with 30% of Holstein cows and 25% of Jersey crossbred cows culled as infertile prior to lactation 5. In addition, more Holstein cows than crossbred cows were culled due to 'feet and leg' problems, with this highlighting the improved hoof health characteristics of Jersey crossbred cows.

Table 3 Full lactation milk yield, milk composition and fat + protein yield for Holstein and Jersey crossbred cows over lactations 1 – 4, studied on 11 farms

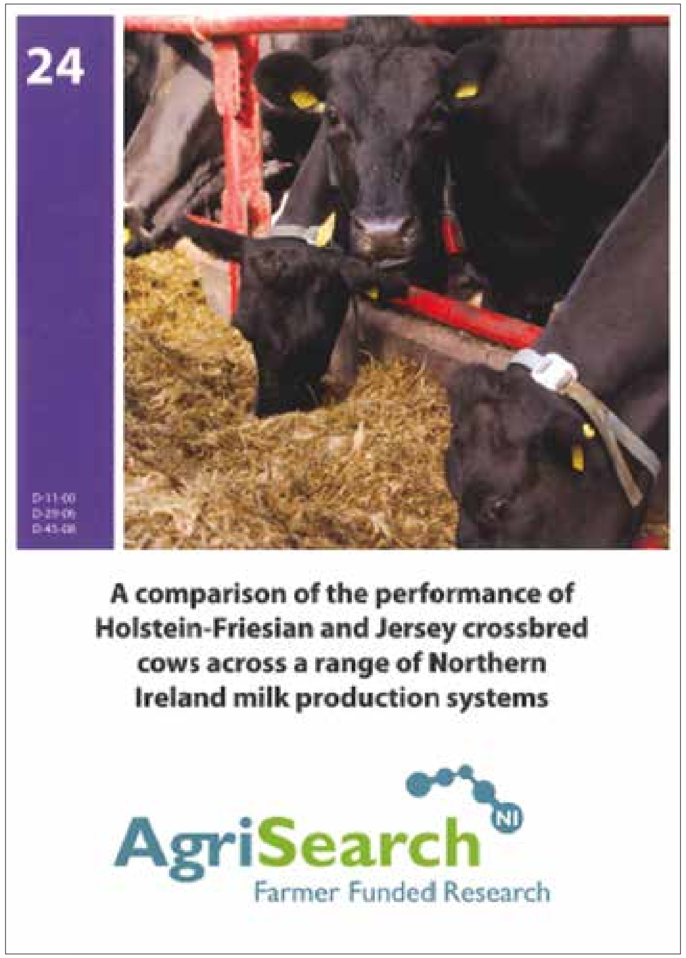
	Holstein	Jersey crossbred
Milk yield (litres)	6900	6130
Milk fat (%)	4.19	4.71
Milk protein (%)	3.39	3.58
Fat + protein yield (kg)	522	508

The financial performance of the two breeds has been compared, with milk yield and milk composition adjusted to take account of the different herd structures arising due to differences in survival between breeds. The analysis has been undertaken at a milk price of 26 pence per litre, with milk price adjusted for compositional bonuses. Differences between breeds in replacement rates, still birth rates, calves sold, and cull cows sold have been included within the calculations. The overall outcome of the economic analysis was that Jersey crossbred cows had a net profit which was £39/cow/year higher than for the Holstein cows.

Farming implications

Within low-moderate concentrate input grassland based systems, Jersey crossbred cows were able to compete with Holstein cows in terms of milk solids output, while having improved health, fertility and survival, and a higher net margin. However, within a high concentrate input system, Jersey crossbred cows did not have the genetic potential to respond to the high feed levels, and portioned some of the extra energy to body tissue.

The full results of these crossbreeding studies are summarised in Booklet Number 24 which is available on the AgriSearch website. These studies were co-funded by DAERA and AgriSearch.



THE PERFORMANCE OF 'THREE-BREED' CROSSBRED DAIRY COWS

Conrad Ferris and Peter Purcell

Key messages

- While milk yield was higher with the Holstein cows, the three breed crossbreds produced milk with a higher fat and protein content. Milk fat and protein yield was unaffected by genotype.
- '3-breed' crossbred cows had a lower mastitis incidence, but similar incidence of lameness as Holstein cows.

Background

A 'dilemma' that is faced by many farmers who adopt crossbreeding is which breed of sire to use on the 'first generation' crossbred heifers and cows. A number of possible breeding strategies exist, including 'back crossing' to one of the original breeds, the use of progeny tested crossbred sires, or the adoption of a 'three-way' crossbreeding programme. The latter strategy (three-way crossbreeding) is often advocated to maximise hybrid vigour in the long term, and this approach has been adopted within the dairy herd at Hillsborough.

The Swedish Red breed was selected as the 'third breed' within the Hillsborough crossbreeding programme, with Jersey x Holstein crossbred cows bred to sires of the Swedish Red breed. The Swedish Red breed was chosen due to the long term focus on health and fertility traits within the Scandinavian countries. Consequently, Scandinavian sires would be expected to introduce positive fertility and health traits.

Research study details

The study involved 72 spring calving dairy cows comprising 36 Holstein cows and 36 three-way crossbred cows. The three-way crossbred cows (3-breed) were the offspring of a breeding programme in which Jersey x Holstein crossbred cows were bred to sires of the Swedish Red breed. Cows of each genotype were managed on either a low (0.7 t) or moderate (1.7 t) concentrate input system for one full lactation.

Research findings

Overall performance of cows of each of the two genotypes (average across the low and moderate concentrate input systems) is presented in Table 1. Holstein cows had a higher intake (1.5kg DM per day higher) than the 3-breed cows during the winter period prior to turnout. This is in contrast to previous AFBI research in which Jersey crossbred cows had similar intakes to Holstein cows. Thus, part of the high intake potential that was a feature of Jersey crossbred cows appears to have been lost with the three-way crossbred cows. While the 3-breed cows had a higher body condition score than the Holstein cows, the crossbred cows were approximately 30kg lighter.

Holstein cows produced approximately 1000kg more milk/lactation than the 3-breed cows, although these cows produced milk with a significantly higher fat and protein content. The overall effect was that milk solids yield (kg of fat plus protein) was not significantly different between the two breeds, with yields of 546 and 520kg for the Holstein and 3-breed cows, respectively. It is likely that the improved milk composition with the 3-breed cows is due to hybrid vigour, and the continuing impact of the Jersey sires used during the first cross. At a milk price of 26 pence per litre (adjusted for current compositional bonuses), the value of milk produced was £1967 and £1830 for the Holstein and 3-breed cows, respectively, but the 3-breed cows had lower feed costs, due to lower intakes.

While conception rates to first AI did not differ between the two genotypes, conception rates after a 14 week breeding period were higher with the 3-breed cows. There were no differences between genotypes in the number of cows treated for lameness. Significantly fewer 3-breed than Holstein cows were treated for mastitis during the course of the study. This lower incidence of mastitis reflected the focus on mastitis resistance within the Swedish Red population, supplemented with the beneficial effects of hybrid vigour. This lower mastitis incidence occurred despite a significantly higher somatic cell count with the crossbred cows. While these two results appear to be in contradiction, it is known that hybrid vigour does not normally reduce somatic cell count, but can reduce the incidence of mastitis quite considerably. A similar finding (lower incidence of mastitis, but no effect on somatic cell count) has been observed in previous studies with crossbred cows at Hillsborough and elsewhere.

The results of this experiment are largely in agreement with findings from studies involving ‘first cross’ Jersey crossbred cows, namely a reduction in milk yield, but no loss in milk solids yield. In addition, overall fertility performance was improved, while the incidence of mastitis was reduced. However, hoof health was not improved with the three-way cross breeding, while intakes were lower.

Farming implications

Previous research at Hillsborough demonstrated that crossbreeding Holstein cows with Jersey sires results in robust cows with similar milk solids yields as Holstein cows, but with fewer health problems and higher levels of fertility. The current study has demonstrated that many, although not all, of these benefits can be maintained when Jersey crossbred cows are bred to Scandinavian Red sires.

Table 1 Performance of Holstein-Friesian and three-way crossbred dairy cows (Swedish Red x Jersey x Holstein) over one full lactation

	Holstein-Friesian	Three-breed Crossbred
Intakes and body tissue		
Total dry matter intake prior to turnout (kg per day)	17.4	15.9
Average live-weight (kg)	559	530
Average condition score	2.2	2.4
Milk production		
Milk yield (kg/lactation)	7310	6378
Milk fat (%)	4.15	4.63
Milk protein (%)	3.34	3.54
Fat + protein yield (kg/lactation)	546	520
Somatic cell count (000/ml)	107	162
Fertility		
Conception rate to 1st AI (%)	37	37
Conception rate after 14 weeks (%)	72	90
Health		
Cows with at least one case of mastitis (%)	26	6
Cows with at least one case of lameness (%)	10	13

ISSUES TO BE CONSIDERED BEFORE ADOPTING CROSSBREEDING

Conrad Ferris

Key messages

- Crossbreeding does not solve poor management or nutrition problems
- Crossbreeding is not a shortcut to true genetic improvement
- Hybrid vigour is when crossbred progeny outperform the average of both parents
- Crossbreeding is a long term commitment that can't easily be erased from the herd
- Any breed used for crossing must have a breed improvement progeny testing scheme.

Background

Previous AFBI studies have clearly demonstrated that crossbred cows can produce similar levels of milk as Holstein cows within low - moderate concentrate input systems, while having improved health and fertility traits. Nevertheless, the adoption of crossbreeding is not a decision that should be taken lightly, and its impact on a herd, both in the short-term and long-term needs to be considered. The following are some of the key issues to consider before embarking on a crossbreeding programme:

1) Crossbreeding will not solve problems associated with poor management or poor nutrition. Many dairy farmers have adopted crossbreeding in an attempt to solve problems that are largely management related, such as high cell counts and lameness. Many of these problems may remain unresolved with crossbred cows. Farmers must clearly identify why they are considering crossbreeding (i.e. what is the problem that they are attempting to solve), and then identify if crossbreeding is likely to provide part of the solution, or if management changes will be equally effective.

2) Crossbreeding does not represent true genetic improvement. True genetic improvement takes place when the top AI sires (for the most economically important traits) are used within that breed. For some genetic 'problems', the solution may well be found within the parent breed. Selection indexes which have a major emphasis on functional traits now exist for the Holstein breed (eg PLI). Through careful sire selection, bulls which can help to overcome existing herd weaknesses can be chosen. Nevertheless, on many herds it will take quite a few generations to reverse some longstanding problems.

3) Hybrid vigour is the additional performance benefits that can be obtained with a crossbred animal that is over and above the average of both parent breeds. For example, if Breed A has a lactation yield potential of 6000 litres, and breed B has a lactation yield potential of 8000 litres, the offspring of the two breeds might be expected to have a potential of approximately 7000 litres (Figure 1). However, the production of the crossbred cow is likely to be approximately 7350 litres. The extra 350 litres of milk is created by hybrid vigour. However hybrid vigour should not be the main reason for adopting crossbreeding. While hybrid vigour can be particularly beneficial for traits such as health and fertility, for other traits such as milk yield, the levels of hybrid vigour can be relatively low (average of 4.7%). Adopting crossbreeding solely to gain the benefits of hybrid vigour is unlikely to be justified. It is critical to remember that this additional hybrid vigour performance will not pass to the next generation but is locked into the animal that was the direct calf of the interbreeding cross.

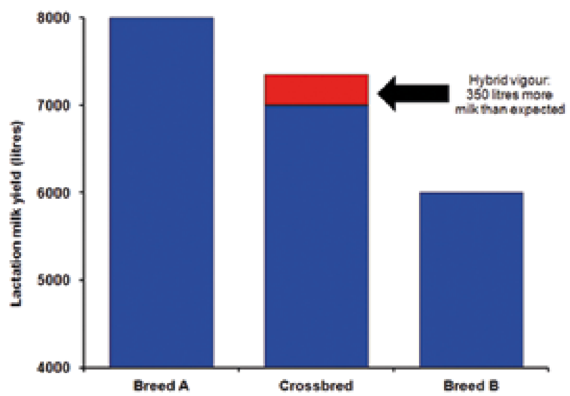


Figure 1 Example of the impact of hybrid vigour on milk production when two breeds are crossed

4) Crossbreeding is a long term commitment. For cows that have been bred to a sire of a different breed this spring, it will be 2-3 years before the potential benefits of these animals becomes apparent within the herd, and at that stage these crossbred cows are unlikely to comprise more that 25% of the herd. Similarly, while 'crossbreeding' can be introduced into the herd during a single breeding season, it can take many generations to 'erase' the impact of a crossbreeding decision if its effects are found to be undesirable.

5) Crossbreeding can complicate management issues, especially in relation to housing and milking facilities. Depending on the breeds used, crossbreeding will often result in smaller cows, and cows with a more diverse range of sizes. While the former may be advantageous within a grazing system, smaller and mixed sized cows can result in problems in the milking parlour and in cubicle houses.

6) The impact of crossbreeding on the value of cull cows, male calves and surplus breeding stock needs to be considered. The impact may vary depending on the breed chosen. For example, the use of the Montbeliarde breed within a crossbreeding programme may well increase the value of cull cows and male calves, while the reverse may be true when the Jersey is used. In addition, the impact of crossbreeding on the long term value of the herd needs to be considered.

7) The choice of the second (and possibly third) breed for use within a crossbreeding programme is a critical decision. A number of issues need to be considered. Firstly, the breed should be suitable for the milk production system in which its offspring will function (i.e. low input grazing vs high input confinement). In most cases, a breed should be chosen to minimise any loss in milk production, while at the same time maximising the gain to be made in other traits. Evidence from AFBI studies would suggest that Jersey crossbreds are not particularly suited to high input systems, while evidence from the US would suggest that Scandinavian crosses are. In addition, any breed being considered for use within a crossbreeding programme should have an associated breed improvement progeny testing programme, with a significant focus on traits of greatest economic importance. To facilitate this, breeds being considered should have a sufficiently large population size to allow ongoing genetic improvements to be made. When choosing a breed the first step is to identify the key goals of the crossbreeding programme, and to identify a breed which will allow these goals to be achieved.

8) The choice of sire within a breed is perhaps even more critical than the choice of breed itself. The perception is still widespread that a bull of a different breed purchased from a 'neighbour down the road' will be suitable for crossbreeding, just because it is of a 'different breed'. This will only do a great disservice to the concept of crossbreeding. Sires used within crossbreeding programmes should be top sires for PLI from within the breed selected.

Farming guidance

Crossbreeding is not for everyone, and on many farms crossbreeding will not overcome problems of poor management. Nevertheless, a well-planned and well managed crossbreeding programme can result in robust cows with fewer calving difficulties, fewer health problems, higher levels of fertility, and ultimately improved longevity. While crossbreeding may have a detrimental impact on some economic aspects such as the value of male calves and cull cows, the positive financial impact associated with improvements in functional traits has the potential to improve overall economic performance of the dairy business.

COW PERFORMANCE WITHIN DIVERSE MILK PRODUCTION SYSTEMS

Conrad Ferris

Key messages

- Concentrate input was key driver of milk production within the systems examined
- Jersey crossbred cows competed well with Holstein cows within the Spring calving systems
- System had little effect on the fertility of Holstein cows, though crossbred cows trended to have improved fertility
- Incidence of lameness and mastitis highest with Holstein cows on the Year-round housing system and Conventional system, lowest with Jersey crossbred spring calving cows on a low input grazing system
- Net margin per litre maximised with the Spring calving systems
- Conventional system had highest net margin per cow at or above 27p/litre, while Spring Calving systems tended to be more profitable at 22p/litre

Background

A wide range of milk production systems are practiced in Northern Ireland. For example, systems differ in terms of calving season (Autumn, Spring and 'year round'), annual concentrate inputs (0.5 - 4.0 tonnes per cow) and milk outputs (4,500 - 12,000 litres per cow), stocking rates (1.0 - 3.5 cows per ha) and overall management regime (Year-round housing, housed-by-night during the summer, full-time grazing). In addition, while the Holstein-Friesian is the predominant dairy cow breed, alternative breeds, and the use of crossbreeding, have been adopted on some farms. The reasons for these different systems are many and varied, and include total land availability, land type, local climate, the size of the grazing platform accessible from the milking parlour, and cow genotype. This AFBI study was designed to compare cow performance within contrasting milk production systems.

Research study details

Twenty cows were managed on one of four different grassland-based milk production systems over three successive years, with these systems summarised in Table 1. Two of the systems involved winter calving Holstein cows, with these systems defined as either 'Year-round housing' (cows housed throughout the entire lactation) or Conventional (winter housing, summer grazing). A third 'Low input' system involved spring calving dairy cows, and was replicated using both Holstein and Jersey x Holstein crossbred cows. Each system was designed to operate at a stocking rate close to 2.5 cows/ha (ie. requiring a derogation), and to minimise nitrogen and phosphorus loss to the environment. All cows were milked twice daily.

Research findings

Table 2 provides a summary of the performance of the cows over the three years of the study. As expected, milk yields were highest with the Year-round housing system and lowest with the Low input grazing systems, with these trends reflecting the differences in concentrate input between systems. The Holstein cows on the Low input grazing system produced 400 litres more milk than the Jersey crossbred cows, but as these cows had higher fat and protein contents, the overall effect was that fat + protein yield did not differ between breeds. Holstein cows on the low input grazing system had the lowest somatic cell count. 'Milk from forage' values were 1470, 2890, 4660 and 4190kg for the Year-round-housing, Conventional and Spring calving Holstein and Spring calving crossbred systems, respectively.

Holstein and Jersey crossbred cows on the Low input grazing system produced similar yields of milk solids, despite the crossbred cows being approximately 60kg lighter than the Holstein cows (Table 3). This highlights the high intake capacity of the smaller Jersey crossbred cows. In addition, these crossbred cows tended to have better fertility than Holstein cows on any of the other systems, with this likely being hybrid vigour arising from crossbreeding. Incidences of mastitis and lameness were lowest with the spring calving cows on the low input grazing systems, with crossbred cows having fewer incidences than Holstein cows.

Financial performance

Irrespective of milk price, net margin per litre (Figure 1) was lowest with the Year-round-housing system and highest with the Spring calving systems. This reflects the lower concentrate inputs, and the increased reliance on grazed grass with the Spring calving systems.

Net margin per cow is presented in Figure 2. In general, the Conventional system was most profitable when milk price was 27 pence per litre, or higher, while at a milk price of 22 pence per litre the Spring Calving systems tended to be more profitable. This finding supports previous modelling work undertaken by AFBI which indicated that moderate-input, moderate-output autumn calving systems (approximately 8000 litres/cow/year), and high output Spring calving systems (approximately 7000 litres/cow/year) are the most financially robust systems for Northern Ireland. The system with the lowest net margin under all milk price scenarios was the Year-round-housing system. This high cost system is particularly susceptibility to low milk prices.

The Spring calving systems involving Jersey crossbred cows were more profitable than those involving Holstein cows (£39/cow/year). This supports the findings of previous comparisons of these two genotypes at Hillsborough.

Nevertheless, it must be recognised that the relative difference in net margin between each of the systems was 'relatively' small when compared to actual differences in net margin within similar systems in practice. This is due to the fact that all four systems operated at high levels of efficiency. This relatively narrow range of net margins indicates that a range of systems can operate with high net margins in Northern Ireland, provided high levels of technical efficiency are achieved within each system. This is in agreement with the findings of CAFRE benchmarking over many years.

It must also be noted that the ranking in net margin within the current study is impacted by many factors, and the margins can be relatively sensitive to changes in the assumptions made. Thus individual farmers, under different circumstances, and with different efficiencies from those within the current study, may have very different net margins from those determined.

Farming guidance

Lactation milk yields across the systems ranged from 6050 to 9330kg, with differences in milk production largely reflecting differences in concentrate inputs. System had little effect on the fertility of Holstein cows, while there was a general trend for crossbred cows to have improved fertility compared to Holstein cows. This study has again demonstrated the improved health and fertility performance of crossbred dairy cows, and the fact that these can compete well with Holstein cows within low input grazing systems.

Net margin per litre was maximised with the spring calving systems. However, when net margin per cow was examined, the Conventional system was most profitable when milk price was 27 pence per litre, or higher. At a milk price of 22 pence per litre the Spring Calving systems tended to be more profitable.

Table 1 Overview of the key components of each of the three systems

	Year-round housing	Conventional	Low input grazing	
Cow type	Holstein-Friesian	Holstein-Friesian	Holstein-Friesian	Jersey crossbred
Calving season	October - April	October - April	January - April	January - April
System overview	All year housing	Winter housing, summer grazing	High reliance on grazed grass	High reliance on grazed grass
Concentrate input (t per lactation)	3.5	2.5	0.8	0.8
Stocking rate (cows/ha)	2.5	2.5	2.4	2.4

Table 2 Effect of system on milk production performance across the three years of the experiment

	Year-round Housing	Conventional	Low input grazing	
			Holstein	Jersey x
Days in milk	326	317	303	302
Lactation milk yield (kg per cow)	9330	8440	6460	6050
Fat (%)	4.49	4.33	4.29	4.90
Protein (%)	3.46	3.49	3.36	3.63
Lactation fat + protein yield (kg per cow)	741	660	495	514
Somatic cell count (000 per ml)	222	209	114	183
Milk from forage (kg)	1467	2888	4658	4184

Table 3 Effect of system on body condition, fertility and health across the three years of the experiment

	Year-round Housing	Conventional	Low input grazing	
			Holstein	Jersey x
Average live weight (kg)	602	581	540	478
Average condition score	2.5	2.4	2.4	2.4
Conception to 1st and 2nd service (%)	41	45	53	68
Calving interval (days)	397	390	382	376
Cows with one or more cases of mastitis (%)	42	41	24	13
Cows with one or more cases of lameness (%)	20	28	11	5

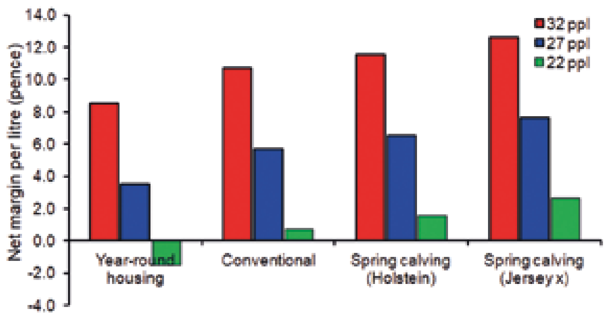


Figure 1 Effect of system on net margin per litre (pence) across a range of milk prices

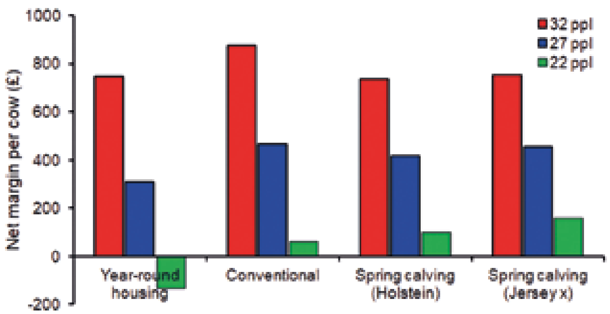
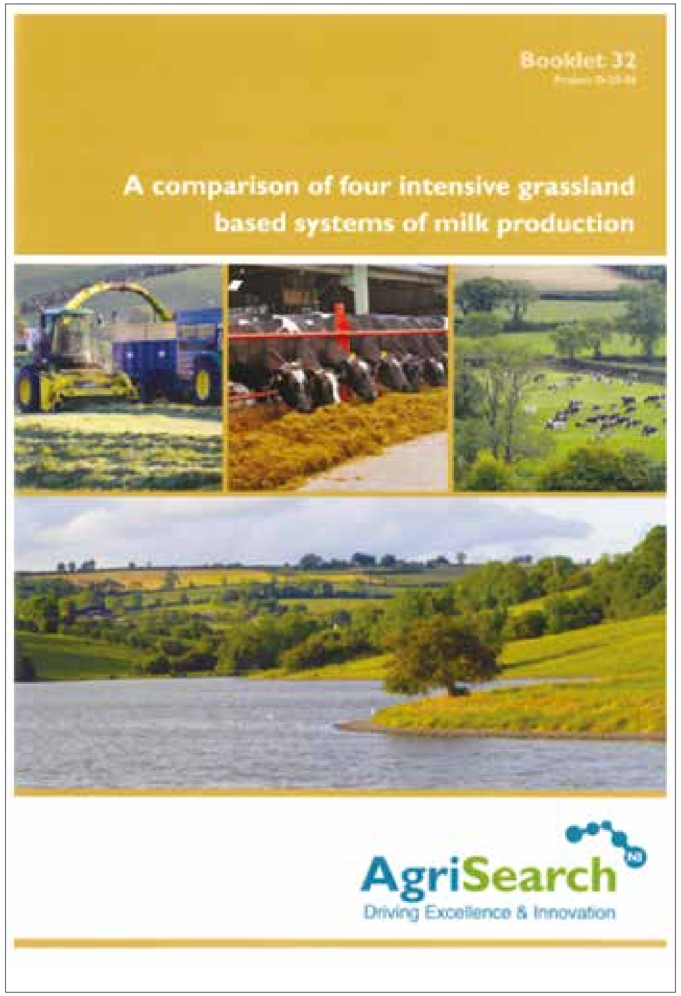


Figure 2 Effect of system on net margin per cow (pence) across a range of milk prices

Footnote Full results of this experiment are available in Booklet Number 32 on the AgriSearch website. Research co-funded by DAERA and AgriSearch



ADVANCES IN ENHANCING THE NUTRITIONAL QUALITY OF MILK

Colin McRoberts, Stewart Floyd, Sharon Stewart and Conrad Ferris

Key Messages

- Compared to cows housed indoors and offered grass silage and zero grazed grass, milk from outdoor grazing cows had higher vitamin D3 concentrations.
- Supplementing dairy cows with rumen-protected microalgae product high in a long chain fatty acid raised the levels of beneficial fatty acid in yoghurt made from their milk

Background

This article presents some of the forefront research that AFBI is conducting to enhance the quality of milk produced in Northern Ireland, both to benefit the consumer and to give locally produced milk added value in competitive milk markets, globally. The article features studies into increasing the Vitamin D content and improving the omega-3 fatty acid profile of milk and milk products.

Enhancing Vitamin D

Vitamin D is produced by the action of sunlight on the skin and through the diet. Vitamin D helps regulate the amount of calcium and phosphate in the body and to keep bones, teeth and muscles healthy. People living at more northerly latitudes have limited Vitamin D synthesis for a considerable part of the year. Foods high in vitamin D include eggs and oily fish such as salmon, sardines and mackerel and are generally not popular with consumers. Several studies have concluded that a significant proportion of the EU population is vitamin D deficient with figures ranging from about 13% to 40%. The recommended intake of vitamin D (European Food Standards Agency) is 15 µg/day for vitamin D with most EU consumers consuming between 3-7.5 µg/day. Consequently, there is interest in increasing the Vitamin D content of more commonly consumed foods, such as milk. AFBI, in collaboration with industry partners, have studied the effect of dairy cow management regime on Vitamin D concentrations in milk.

Vitamin D research details

Three management strategies were examined using 114 Holstein-Friesian dairy cows (i) housed with grass silage (Silage), (ii) housed with fresh grass (Zero-Grazing), (iii) full-time grazing (Grazing). Concentrate supplementation was the same for all three systems. Cows within the Silage and Zero-Grazing systems were housed in cubicle accommodation while cows on the Grazing system were given access to fresh herbage daily. Milk samples were taken on 6 July and 20 September, and analysed for several types of vitamin D: vitamin D3, vitamin D2, 25-hydroxyvitamin D3 (25-(OH)-D3) and 25-hydroxyvitamin D2 (25-(OH)-D2).

In addition, the use of special UV lights in animal houses are under investigation, to simulate the effect of sunlight during those periods of the year when cattle are normally housed.

Vitamin D research findings

Both management system and sampling date had a significant effect on vitamin D3, D2 and 25-(OH)-D3 concentrations (Figure 1). Compared to the indoor treatments (Silage and Zero-Grazing), milk from outdoor Grazing cows had higher mean concentrations at both sampling dates, for vitamin D3 and its metabolite 25-(OH)-D3, and higher vitamin D2 concentrations on the first sampling date. The concentrations of 25-(OH)-D2 were below the detection limit in all three systems.

With outdoor Grazing cows, Vitamin D concentrations were significantly higher in July than September. This was apparent by a significant change in concentration in Grazing cows between the two sample dates for vitamins D3 and D2 (though not 25-(OH)-D3), that was not apparent in milk for the other two systems. Furthermore the preliminary studies on the use of artificial UVB light for raising vitamin D levels in milk from housed cattle appear to be showing some positive responses.

Vitamin D enhancement implications

This research demonstrates that a benefit of keeping cows grazing outdoors is that they will produce milk with higher concentrations of Vitamin D3 and 25-(OH)-D3 than housed cattle, irrespective of diet. To determine the full potential value of in-house UVB lights will require further study.

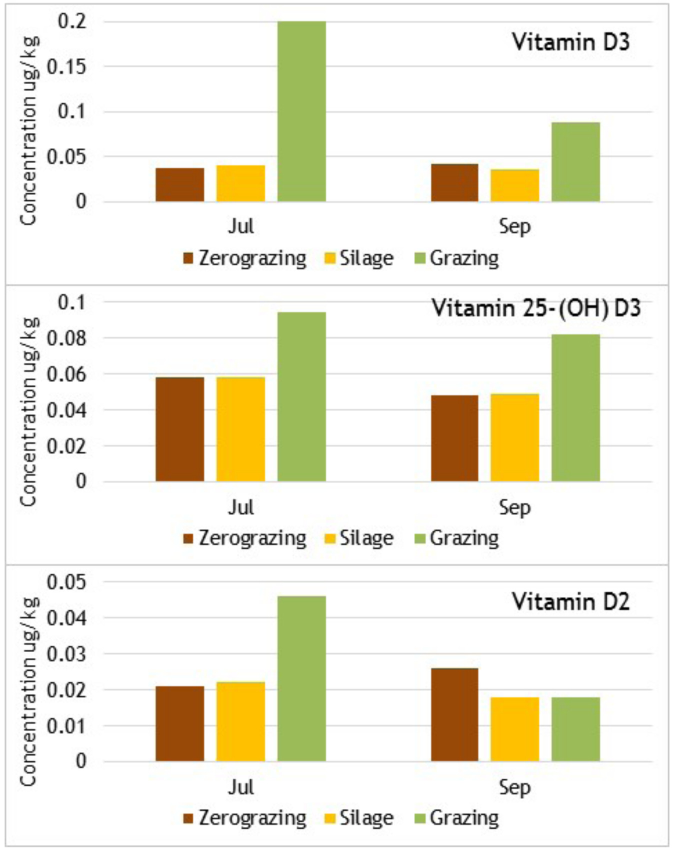


Figure 1. Effect of management regime and date of sampling on concentrations of vitamin D in milk.

Enhancing omega-3 fatty acids

AFBI have also conducted research, funded by DAERA, on methods to enhance the concentrations of omega-3 fatty acids in milk and dairy products

A study led by Dr Ann Fearon investigated methods of enhancing fatty acid levels sufficiently that products made from the milk could be labelled a "source of" or "high in" omega-3 polyunsaturated fatty acids (n-3 PUFAs). The study showed that supplementing the diet of dairy cows with several levels of a rumen-protected microalgae product high in a long chain fatty acid (docosahexaenoic acid DHA) raised the levels of n-3 PUFAs sufficiently, that yoghurt made from the milk contained approximately 40 mg per 100g yoghurt.

A second study investigated the production of reduced fat cheddar cheese fortified with omega-3 through incorporation of n-3 PUFAs during processing. Sensory evaluation testing found that consumers could not detect any difference in flavour or acceptability between the omega-3 fortified and the normal unfortified reduced fat cheeses, but would benefit from the enhanced nutritional value of the fortified cheese. Therefore these studies showed the potential to produce enriched dairy products through fortification in the cow or biofortification of the milk product.

THE AFBI CATTLE HEALTH SCHEME

Siobhan Corry, Maria Guelbenzu and Helen Gibney

Key Messages

- The scheme aims to reduce or eradicate five of the most important non-statutory diseases, prevalent in local dairy herds
- A key element of these disease control programmes is sound biosecurity practices
- Participation brings benefits beyond protecting herd health and welfare that contribute to the profitability of dairy farming

Background

AFBI offers a Cattle Health Scheme to provide programmes for the monitoring, control and eradication of diseases, working closely with herd owners and their veterinary surgeons. The Scheme is licensed by, and operates to the standards of Cattle Health Certification Standards (CHeCS). This is a self-regulatory body established by the cattle industry for the control and eradication of non-statutory diseases.

In addition to testing requirements, herd biosecurity is a very important component of the disease control programmes. A key benefit of the scheme is the emphasis on sound biosecurity practices. These include requirement for

- The accredited schemes for Infectious Bovine Rhinotracheitis and Bovine Viral Diarrhoea that involve
  - double fencing (or an equivalent gap of at least 3 meters between animals and any neighbouring stock)
  - or a compulsory vaccination programme in the absence of double fencing for the vaccinated monitored free schemes for IBR and BVD.
- The isolation and testing of any newly introduced animals into the herd and animals returning from show or sale

There are additional rules and guidelines in relation to grazing, slurry and manure management, colostrum, feed and bedding, water sources and the sharing of veterinary and farm equipment.

AFBI cattle health scheme members and their veterinary surgeons can avail of the advice and guidance of the cattle health team at AFBI for any queries regarding testing, biosecurity requirements or analysis of results. The programmes may be used for routine monitoring, disease reduction, disease eradication and for disease free accreditation or risk level certification.

Cattle health scheme overview

The scheme includes programmes for five of the most important non-statutory diseases, prevalent in both beef and dairy herds in the UK and Ireland.

1. **Bovine Viral Diarrhoea (BVD)**

   BVD virus causes a complex of diseases in cattle, the most important of which interfere with reproduction, affect the foetus and can lead to persistent infection and mucosal disease.

   AFBI Cattle Health Scheme members are now availing of the compulsory BVD eradication Programme in NI as a means of monitoring BVD in their herds, and ultimately gaining or maintaining accredited free status within the Cattle Health Scheme BVD programmes, in combination with biosecurity measures.

2. **Infectious Bovine Rhinotracheitis (IBR)**

   IBR, caused by bovine herpes virus 1 (BoHV-1), causes acute upper respiratory tract disease, milk drop, reduced fertility and abortion.

   In participating herds, all animals over twelve months of age, plus any non-homebred animals are tested annually. For herds participating in the IBR vaccinated monitored free scheme, the IBR gE serology test is used, which can distinguish between field virus and vaccination with a gE deleted (marker) vaccine.

3. **Leptospirosis**

   In cattle, leptospirosis is caused by two organisms collectively referred to as Leptospira Hardjo. Infection can result in milk drop, infertility, abortion and the birth of weak calves.

   In participating herds, all animals over two years of age, any animals between one and two years of age destined for breeding, and any non-homebred animals are tested annually.

4. **Johne's Disease**

   This disease, caused by Mycobacterium avium subspecies paratuberculosis (MAP), is a chronic, progressive, wasting condition that affects ruminants. The infectious agent is shed in faeces, can cross the placenta and can be found in colostrum and milk. Infection is commonly gained in the first 6 months of life via ingestion of the agent, but clinical signs of weight loss and diarrhoea do not occur until adulthood. Heavily infected herds are likely to see a high rate of wastage in cattle between three to five years of age.

   Tests carried out on blood or milk samples for antibodies or testing faeces for MAP are valuable procedures for the diagnosis of Johne's disease. However, they can only be reliably used to detect infected animals in the later stages of infection in the short period before clinical disease becomes apparent. This means that infected animals may test negative on several occasions at annual tests before they test positive. Testing individual animals at the point of sale is of very limited value. Nevertheless the tests are a good indicator of herd infection. If a herd repeatedly tests negative for the disease at annual intervals, the herd can be categorised as low risk with regards to Johne's disease.

As the diagnosis of the disease is difficult and because the organism survives well in the environment, control and eradication of Johne's disease is more difficult than for the other diseases in the AFBI cattle health scheme. A test and cull programme must be supplemented by the removal of offspring of any test positive dam from the breeding herd and by a hygiene programme designed to reduce calf exposure to faeces from adults and to reduce the amount of faecal contamination for all ages of breeding stock.

Herds participating in the certification programme must carry out an annual herd test and adhere to other mandatory requirements of the scheme, designed to support the control and prevention of Johne's disease. A Johne's disease health plan must be in place for the herd and be updated annually in consultation with the herd's veterinary surgeon.

Herds are allocated a risk level between 1 and 5, with level 1 being associated with the lowest risk of Johne's disease in relation to buying breeding stock from participating herds. For dairy herds there is a risk level reduction programme, aimed at reducing disease prevalence over time.

The testing regime involves an annual serology test on all animals over two years of age. Any animal testing serology positive must then be tested for the presence of MAP in the faeces by culture or PCR.

The long term goal is to achieve freedom from the disease but the removal of test positive animals is not a strict requirement. Herd can be monitored by an annual blood test or quarterly milk samples. Animals are defined as low, medium or high risk on the basis of results.

5. **Neosporosis**

Neosporosis, caused by the protozoan parasite Neospora caninum, is a major cause of abortion in cattle, accounting for over 5% of abortions submitted to AFBI for post-mortem in which an agent was identified. The CHeCS Neosporosis Risk-Level Certification Programme is designed to reduce and ultimately eradicate the disease from a herd whilst providing the herd with a risk status based on testing and control methods. The objective of the programme is to provide an assessment of the risk of Neosporosis being present in the herd. The aim is to provide a control programme that achieves a reduction in the risk of Neosporosis within the herd while allowing the marketing of cattle with an accredited risk level by identifying test positive animals and removing these from the herd in order to reduce the impact of the disease.

Herds are moved from risk level 5 to risk level 1 as these effective measures of controlling the disease are put in place. A risk level is assigned on the basis of the results of annual herd testing of all female animals aged two years and older, plus any females between one and two years of age which are intended for breeding and any purchased females. A herd risk level is also based on the herd adhering to the CHeCS rules there are mandatory requirements that support the control and prevention of Neosporosis

Farming guidance

Farmers who join the AFBI Cattle Health Scheme can improve the health of their herd as they progress towards accreditation and risk level certification. The change in management practices bring a number of benefits to the farm business beyond protecting the health and welfare of the herd that will further contribute to the profitability of the dairy enterprise.

Agri-Food and Biosciences Institute
Cattle Health Scheme

HEALTH AND WELFARE PLANNING FOR YOUNG DAIRY CALVES

Jason Barley

Key Messages

- Specific disease control beginning from the start of life is essential
- Correct feeding should ensure antibodies to infection are transferred in the colostrum within the first six hours of life
- Inadequate control measures can lead to a 'bottleneck' of disease with calves becoming infected very early in life

Background

Calves produced in a dairy herd are reared either as replacement breeding stock or for beef production. Whichever is the case a good start in life based on common sense, sound management and specific disease control is essential. Sometimes dairy herd health planning concentrates on mastitis, lameness and infertility and whilst the importance of these cannot be disputed, calf health should never be regarded as any less important.

Management aspects

Accommodation

Calving accommodation must be hygienic and available in sufficient quantity to prevent over-use and allow proper cleaning and disinfection. Failure in this regard can lead to a 'bottleneck' of disease with calves becoming infected very early in life regardless of later rearing conditions. Hygiene, ease of cleaning and comfort are very important aspects of calf rearing accommodation.

Important Features of Calf Rearing Accommodation:

- Dry
- Well bedded
- Supply of fresh, clean water
- Well ventilated but draft free
- Right sized, with sufficient space
- Easily cleaned and disinfected
- Used on an all in all out basis without mixing age groups.

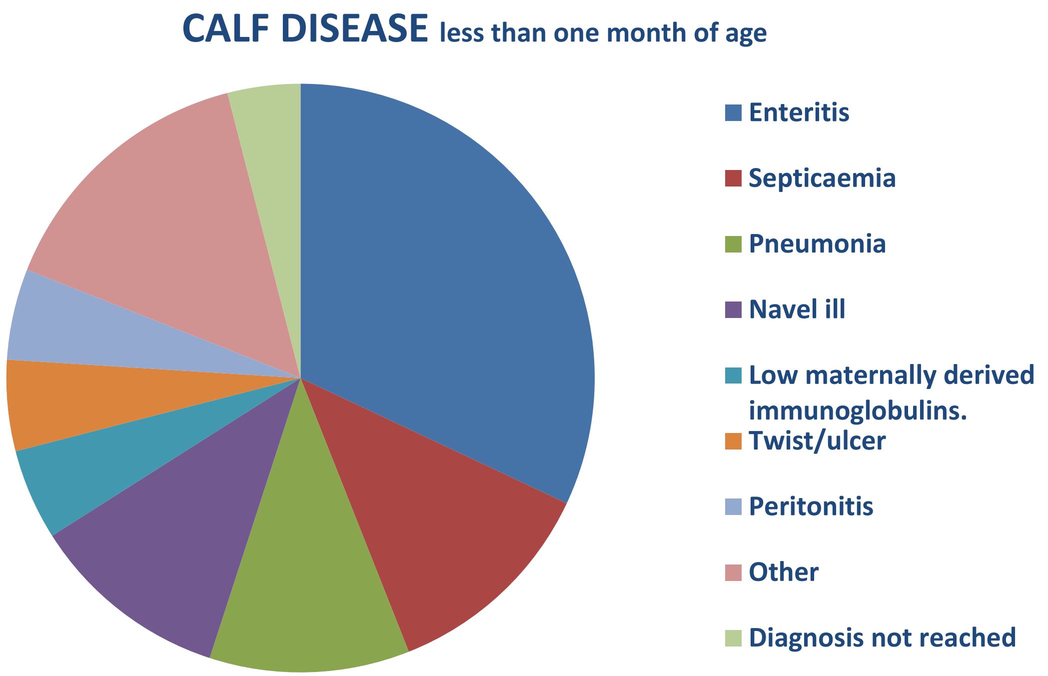
Feeding

Dairy calves should be left on their dam for at least 12 and preferably 24 hours after birth. The calf acquires passive immunity (antibodies) to infection by ingestion of around 3 to 4 litres of colostrum within the first six hours of life. Failure to do this will mean an increased susceptibility to infectious diseases including enteritis and respiratory conditions. The zinc sulphate turbidity (ZST) test can be carried out on serum to give an indirect measure of immunoglobulin concentrations. In calves less than two weeks of age this concentration can be used to evaluate the adequacy of the passive transfer of maternal immunity to the calf via the colostrum. The ZST test is reported in units of turbidity with a result of 20 units or greater considered being indicative of the adequate transfer of immunity. Calf health plans should include the periodic screening of batches of 4 to 6 calves for ZST levels.

Correct feeding of calves should minimise nutritional problems such as failure of oesophageal groove closure, chronic nutritional diarrhoea, abomasal and ruminal bloat and abomasal ulceration.

Calf diseases

Pie Chart below shows a schematic representation of the most common causes of death diagnosed by the AFBI laboratories in young calves in Northern Ireland



Enteric infections (Calf diarrhoea)

Enteritis continues to be the most common cause of mortality in neonatal calves in Northern Ireland. Among carcases in which enteritis is diagnosed as the cause of death, Cryptosporidium spp. is the enteric pathogen identified with greatest frequency. Cryptosporidium is isolated in 33% of young calf faecal samples. Rotavirus is also commonly identified in 28% of young calf faecal samples. Low levels of colostral antibodies were recorded in a high number of neonatal calves which were submitted to AFBI for post-mortem, which underlines the role played by appropriate colostrum management in the prevention of neonatal disease.

Cryptosporidiosis is associated with profuse diarrhoea in neonatal ruminants, with infection passed from carrier cows or via oocysts, which are very persistent in the environment. Salmonella Dublin is commonly associated with enteric infections and septicaemia (blood poisoning) in calves. In Northern Ireland. Control of salmonellosis involves hygiene measures, biosecurity and vaccination.

E.coli K99 is an important cause of neonatal enteritis in young calves, typically less than three days of age. These strains of E.coli preferentially colonise the lower small intestine and produce toxins that cause secretion of water and electrolytes from the intestinal mucosa, resulting in rapid dehydration. E.coli infections are frequently combined with rotavirus and / or coronavirus infections. E.coli/rotavirus/Coronavirus vaccination of the cow will increase protection against these infections, provided the calf sucks adequate amounts of colostrum.

Farming guidance

Ensuring that the lifetime performance potential of dairy stock is fully achieved begins immediately after birth, with hygienic and sufficiently spacious accommodation, ensuring the calf acquires antibody protection by ingestion of sufficient colostrum within six hours of birth and correct feeding to minimise nutritional problems developing. This is equally as important to the good health and performance of the herd as adopting practices to avoid mastitis, lameness and infertility in later life.

CATTLE ABORTION IN NORTHERN IRELAND

Siobhan Corry and Jason Barley.

Key Messages

- When abortion rates exceed 3-5% or occur in close succession, the cause needs investigating
- All abortions should be reported to DAERA in case brucellosis is a possible cause
- As some infectious abortion agents can also harm humans, good hygiene and cautious handling of aborted material is vital

Background

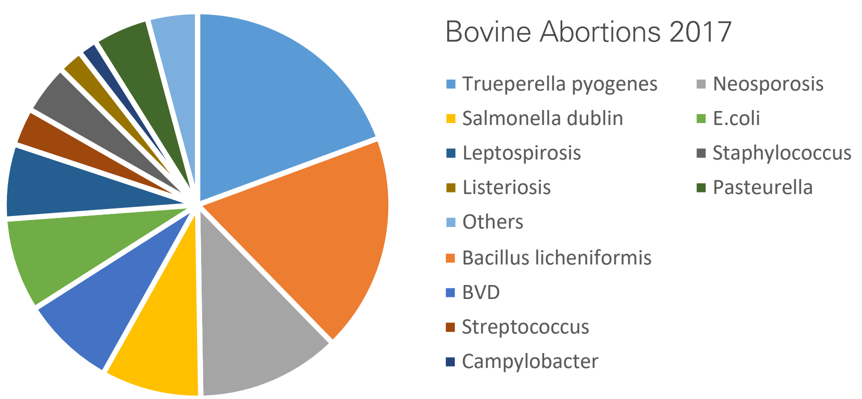
Abortion in cattle is a significant cause of livestock wastage. In dairy herds not only is there the cost of the loss of the calf but also the cost of the lost lactation. Aborted animals can be delayed going back into calf which adds to the losses. Abortions can occur in any herd but once the abortion rate exceeds 3-5% or if abortions occur in close succession there may be cause for greater concern. It is important to determine the cause of an abortion and identify any risks that the herd may be facing. The causes of abortion can be identified into infectious and non-infectious.

All abortions in cattle should be reported to DAERA in case brucellosis investigation is required.

Remember that a lot of the infectious agents responsible for cattle abortions are also zoonotic organisms meaning that they can also cause harm to people. Care should be taken when handling aborted material and good hygiene practices should be followed.

Common causes of abortion in cattle in Northern Ireland

The pie-chart below gives a summary of the causes of bovine abortion diagnosed in Northern Ireland during January to December 2017



This pie-chart shows that of the 438 bovine abortions and stillbirths examined, significant pathogens were detected in 191 cases (43.6%). Of these, T. pyogenes (37 cases, 8.5%) was the most commonly identified pathogen. Other pathogens identified included N.caninum (23 cases, 5.25%), B. licheniformis (35 cases 8%), E.coli (15 cases, 3.4%) and BVDV (15 cases, 3.4 %).

Investigation of cattle abortions

Diagnostic Submissions from Bovine Abortions: Investigation of abortion requires input from the farm veterinary surgeon AND THE SUBMISSION OF MATERIAL TO THE DIAGNOSTIC LABORATORY. In some cases the blood sampling of aborted cows may shed further light on the cause of the problem, but this approach cannot fully replace the proper examination of foetal material.

Foetus and placenta members are the best diagnostic samples and a representative number of abortions should be submitted. Inadequate samples compromise diagnosis and waste money. Always remember that the submission of abortion material is as much to rule out some causes as to rule in others. Non - detection of an infectious cause may mean the cause of the abortion is metabolic or due to placental failure (the nature of which is not very well understood in cattle)

Prevention of cattle abortion

Vaccination and biosecurity: Sound biosecurity practice including a buying in and quarantine policy are very important to avoid bringing in potential causes of abortion such as BVD and IBR.

Blood testing of heifers or cows whilst in quarantine may be useful especially for BVD (test for both antibody and virus) and IBR.

Sourcing accredited breeding replacements through herds which are members of the AFBI Cattle Health Scheme (or similar schemes for animals imported from GB) is an important means of reducing the risk of infectious abortion due to BVD, IBR or leptospirosis entering the herd.

Vaccination against potential causes of abortion – BVD infection, leptospirosis, IBR, Salmonella Dublin and Salmonella Typhimurium is possible and should be practised when the risk is considered large enough to justify this.

Farming guidance

As cattle abortion brings a significant reduction in revenue through the loss of the calf and that lactation plus potential delays in getting back into calf, investigation for a possible cause should be followed through if occurring in 3-5% of births or in close succession.

AFBI ADVANCES BOVINE TUBERCULOSIS (BTB) SCIENCE

Adrian Allen, Andrew Byrne and Robin Skuce

Key Messages:

- Bovine TB is the most complex, costly multi-species endemic disease currently facing the UK and Irish dairy industry
- AFBI plays a central function in supporting DAERA and the industry by providing laboratory confirmation of bovine TB, gamma interferon testing and stain typing
- AFBI R&D is using cutting edge science to better understand the disease and look at control methods directed at accelerating disease eradication

Background

Bovine TB is a serious infectious disease of cattle caused by the bacterium Mycobacterium bovis. The disease is considered the most complex and costly multi-species endemic disease currently facing the government, veterinary profession and farming industry in the UK and Ireland where it impacts negatively on farm profitability and trade, and the well-being of affected farming families. It can also decimate years of livestock breeding.

Bovine TB has a notoriously complex epidemiology with current evidence indicating both cattle and wildlife (badger) sources of infection. Consequently, additional tools, approaches and understanding are needed to deliver long-term control and ultimately eradication.

AFBI plays a central function in supporting DAERA and the industry by providing laboratory confirmation of bovine TB in samples from reactor and other cattle, blood (gamma interferon) testing, pathogen ("strain") typing and supporting various wildlife surveys and other studies. As scientists, our role is also to provide new tools, knowledge and evidence to help accelerate disease eradication through research and development work, which is often undertaken in collaboration with other centres of excellence and leading researchers. Selected highlights are discussed below.

Evaluation of TB test performance

The basis of the eradication scheme is the accurate screening of herds for bovine TB and the identification of infected animals within such herds. AFBI science has improved our understanding of the performance characteristics of statutory tests, including the Single Intradermal Cervical Comparative Tuberculin (SICCT) skin test, the interferon gamma test (IFNg), and commercially-available serological tests. AFBI has recently used cutting-edge Bayesian latent class modelling to estimate the sensitivity (ability of a test to disclose truly infected animals within a population) and the specificity (ability of a test to not disclose uninfected animals within a population) of the IFN-g, SICCT, and post-mortem abattoir surveillance of bovine TB lesions. Furthermore, an AFBI investigation of the fate of SICCT-negative but IFNg-positive animals quantified the future risk that such animals pose to herd OTF status. AFBI has also recently investigated the relative performance of serological tests and whether such tests might be used as ancillary tools to current statutory tests. Such research provides a strong evidence base for policy development, but also informs understanding of how best to manage risk within farms.

Chronically-infected herds

The majority of bovine TB reactor cattle are disclosed in a small proportion of breakdown herds. This is related to the size of breakdowns, but also, importantly, the length of time herds remain restricted due to failing to clear infection. AFBI is undertaking research to gain a better understanding of such herds and to help provide an evidence base for policy and management. Using Geographical Information Systems and spatial-temporal analyses, AFBI scientists have been able to identify clusters of chronic infection. Furthermore, risk factor analyses have revealed a number of important factors associated with chronic herds.

Potential impact of concurrent infections

AFBI has just completed a DAERA-funded project investigating the potential impacts of co-infection on the diagnosis and risk of bovine TB in cattle and herds in Northern Ireland. The study concentrated on three important endemic pathogens – bovine viral diarrhoea virus (BVD), Johne's disease, and liver fluke. The project has yielded important information on these endemic diseases, including the spatial distribution of liver fluke and BVD risk factors in Northern Ireland. Importantly, this research has revealed some associations between Johne's disease and bovine TB diagnosis, and work in this area is on-going

Wildlife – the badger

Badgers are a bovine TB wildlife reservoir in Northern Ireland. AFBI scientists have been involved in understanding badger population dynamics and associated risk to herds using case studies from the Republic of Ireland. This research has highlighted the significant spatial (space) and temporal (time) variation in bovine TB prevalence across badger populations. Furthermore, ecological studies have revealed how badger density varies significantly across areas and this can impact on how far and how frequently badgers move. Current AFBI research on badgers in Northern Ireland is looking at their broad-scale population genetic structure and is investigating M. bovis infection dynamics using the TVR population as a case-study.

New Insights into Pathogen Transmission Dynamics

Molecular microbiology is providing unprecedented insights into disease transmission dynamics of bovine TB. As an example, AFBI has developed a tool-box of molecular tests to investigate the epidemiology and evolution of bovine TB bacteria. Deep ancestry tests show that the UK and Ireland are dominated by their own strain family. Using higher resolution techniques, the multiple strains show striking geographical clustering; this indicates that bovine TB tends to be a series of locally-driven epidemics. These data are made available routinely by AFBI to DAERA to help inform outbreak investigations. A recent collaboration with the University of Glasgow used the highest possible level of resolution i.e. bacterial whole-genome sequencing and mathematical modelling to provide the first direct genetic evidence of ongoing transmission between cattle and badgers at the individual farm scale. This study also detected signals consistent with cattle-cattle spread (amplification) within some of the study herds. These insights provide key pieces of the local evidence base.

Genetic resistance to bovine TB

A number of traditional quantitative genetic studies have identified heritable genetic variation in the risk of cattle becoming infected with bTB. These studies were based initially on the Holstein breed and showed that there were high and low risk sires for bTB. Such genetic variation should be exploitable via selective breeding, by promoting lower risk sires and avoiding higher risk sires. Subsequently, industry-led national genetic evaluations for improved TB resistance (TB Advantage) in dairy cows have been produced by AHDBdairy and the Scotland's Rural College (SRUC).

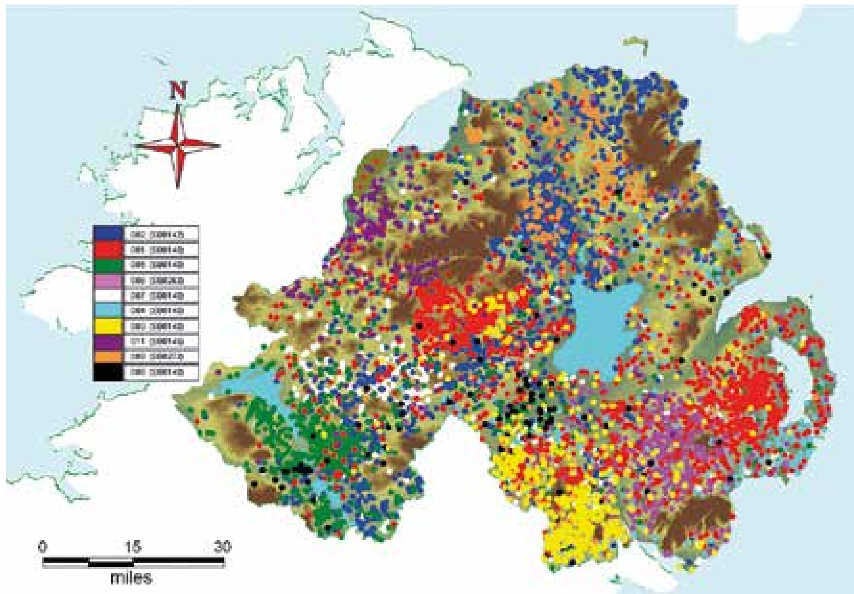
Parallel to this quantitative work, a collaboration between AFBI and the Roslin Institute (University of Edinburgh) undertook a case-control study that mapped the genetic variants associated with bovine TB resistance. This study demonstrated that genomic prediction, which is very much seen as the future of cattle breeding, would be feasible to accelerate further the genetic gain achievable using genetic selection for TB resistance.

Farming benefits

Advances in epidemiology, biological computing and molecular microbiology are allowing AFBI to investigate disease risk, to gain insights into disease transmission and to develop new approaches to disease control in ways that were inconceivable only a few years ago. These capabilities and advances increasingly underpin our work to provide sustainable control of infectious diseases in livestock and in turn support local food production and export trade.

AFBI R&D uses advanced molecular typing, bacterial whole genome sequencing and mathematical modelling to investigate bovine TB transmission.

AFBI has developed DNA fingerprinting methods which allow the identification and tracking of genetically distinct bovine TB strains. This shows a striking geographical localisation of the top 10 most prevalent bovine TB strains.



CAN TECHNOLOGY IDENTIFY HEALTH AND WELFARE ISSUES IN DAIRY CALVES?

Gillian Scoley and Steven Morrison

Key messages

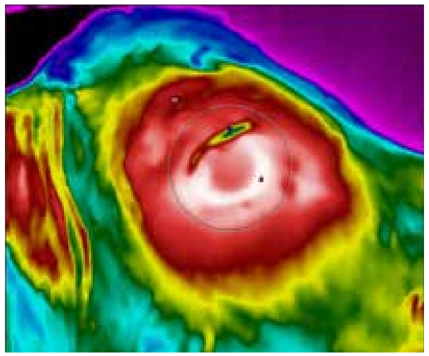
- If we measure it we can manage it!
- Stress and ill-health in early calfhood can impact on future productivity.
- Developments in non-invasive technologies are increasing the opportunities to collect behavioural and physiological measurements from individual calves.
- Incorporating novel technologies into pre-existing rearing systems offers the potential to assist producers and develop early warning systems for calf ill health

Background

During early calfhood there are many common management practices and changes in environment and nutrition, which, if handled improperly can impact negatively on both calf health and welfare. Growing public awareness of farm animal health and welfare combined with new targets for reduction in antimicrobial usage has prompted interest in the development of early warning systems for health and welfare issues. A major issue for animal welfare science is that many of the traditional measures for assessing stress such as blood sampling and behavioural observations can be intrusive, subjective and time consuming. Increasing herd sizes and labour demands can also lead to constraints on time spent on individual monitoring of calves, potentially leading to increases in calf ill-health. Research at AFBI Hillsborough is currently investigating the potential of several new technologies as early indicators of animal health and welfare.

What technologies are we using?

Several technologies which could be implemented within existing management systems are currently being investigated at AFBI Hillsborough.



Thermal Imaging

Thermal imaging is a technology that is increasingly being used in veterinary medicine to examine inflammatory conditions such as mastitis and lameness. Stress and ill-health can cause changes in blood flow, this in turn causes changes in radiated heat production which can be picked up by the thermal camera. In studies at Hillsborough, increases in eye temperature have been observed up to 3 days prior to an increase in core body temperature that would be considered indicative of ill-health (Figure 1). This presents an opportunity to pick up on and treat ill-health at an earlier stage and on an individual basis. Work is continuing to examine if eye temperature can be correlated to core body temperature and early results are promising (Figure 1).

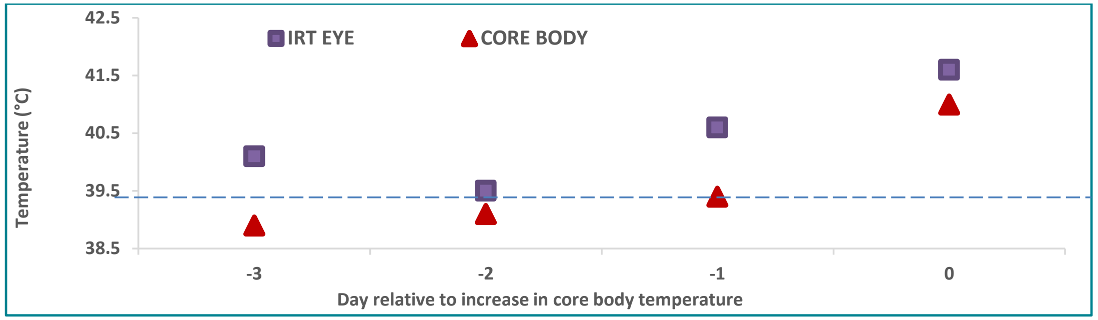


Figure 1. Comparison of core body and infrared eye temperature in a dairy calf prior to the onset of fever

Activity monitors

Pre-wean calves place a high value on rest and can spend up to 80% of their day lying down. Deviations in lying behaviour can be indicative of ill-health or stress. However when rearing calves, especially if in a group housed system, it is difficult for producers to monitor individual calf behaviour and pick up on changes in activity. Several projects spanning various common management strategies, are examining the use of leg mounted activity monitors to provide detailed, automated information about calf standing and lying behaviour throughout the day. Data collected has highlighted the potential for detecting differences in the behaviour of sick and healthy calves (Figure 2), which could otherwise have gone unnoticed. These sensors offer the opportunity to collect detailed behavioural measurements of individual animals which could be used to pick up on ill-health at an early stage.

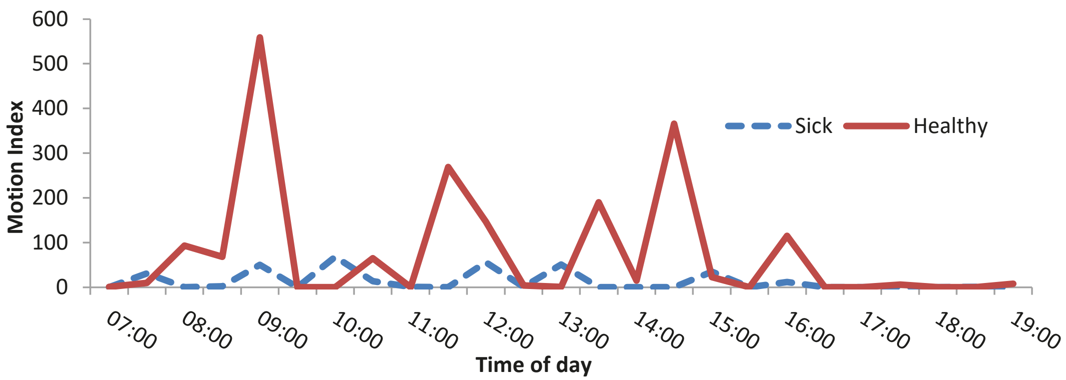


Figure 2. Example of differences in activity levels of sick and healthy calves as detected by leg mounted motion sensors

Heart rate monitors

Heart rate variability, a measure of the difference in time between heart beats, is a potentially non-invasive method of measuring stress. Low heart rate variability has previously been reported in animals under conditions of environmental, physical and physiological stress, and has therefore been suggested as a potential risk factor for ill-health. Research at AFBI is currently employing the use of heart rate monitors in calves undergoing various weaning and feeding regimes to examine the impact of these regimes with the aim of developing strategies to help mitigate potential stress (Figure 3).

Conclusions

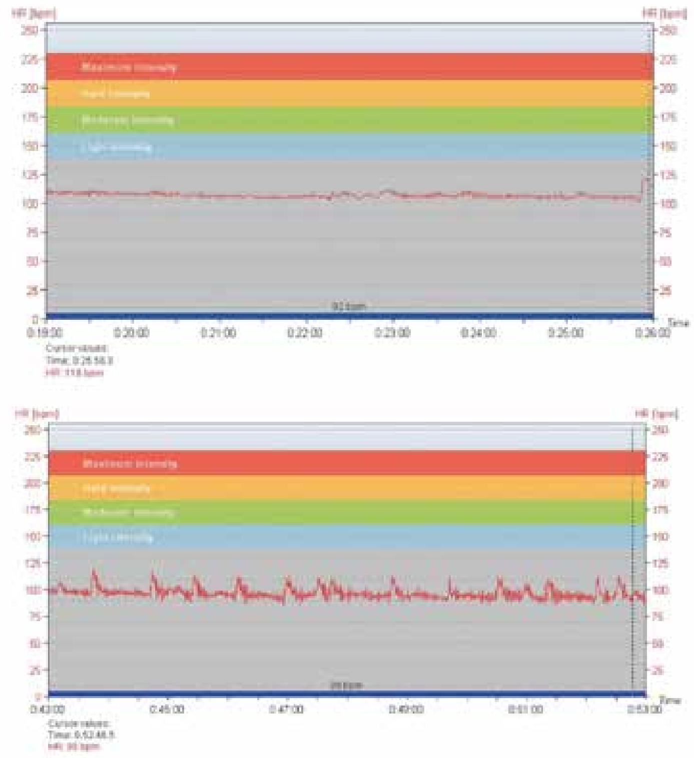


Figure 3. Example of low and high heart rate variability in pre-wean calves

Farming guidance

Continuing developments in monitoring technologies are increasing the options and means of measuring different aspects of animal health and welfare. These technologies could help provide producers with labour saving means of monitoring calves on an individual basis, in the near future. Research at AFBI Hillsborough is combining the use of new technologies with traditional measures of animal performance and health to examine the potential for developing early warning systems for health and welfare. Farmers will in time be able to adopt this innovation to improve their management of the herd.

Footnote: These studies were co-funded by DAERA and AgriSearch.

USING TECHNOLOGY TO MONITOR BEHAVIOUR FOR IMPROVED HEALTH AND WELFARE

Stephanie Buijs

Key Messages

- Behavioural change is often the first signal of an animal in difficulty
- Technology for automatic, continuous monitoring of behaviour can alert farmers
- Biting, chewing ruminating and movement sensors track animal behaviour at grass
- Current AFBI research is developing procedures for using digital technologies to detect behavioural changes as early warning systems for use on farm

Background:

A change in behaviour is often the first outward signal that something is wrong with an animal, as they will adapt to changes in their internal state and their environment to be as comfortable as possible. As such, assessing behaviour is of great importance to detect health and welfare problems at an early stage. Some changes are obvious, for instance a large proportion of the herd avoiding a part of the building where a draught occurs. However, many behavioural signs are much more subtle and will only occur in certain individuals. For instance, an increased number of changes of the lying posture during the very early stages of mastitis, if detected provides an early alert and prompt intervention. Detecting these more subtle behavioural changes requires an in-depth knowledge of the normal behaviour of each individual in the herd, as well as near-continuous monitoring of how their behaviour is changing. Achieving this by direct observation of behaviour is usually an impractable task, not only out on farm but even in a research setting.

AFBI research initiative

Fortunately, there is now an increasing number of technological solutions available to monitor the behaviour of individual dairy cows automatically, allowing continuous monitoring over a prolonged time. AFBI is not only involved in the development of such technologies, but has also made strategic investments in monitoring devices that are now implemented within ongoing studies. A good example of this is a newly started project on the effects of pasture rotation in which a variety of technologies will be used to measure grazing, activity and social behaviour.

'Bite meters' will be used to make sure no bite goes undetected. Not only do these record biting and chewing behaviour, they can even determine if the cow is ruminating, chewing on fresh grass or taking the next bite. This highly specific measure of grazing behaviour will be combined with data on walking, standing and lying behaviour acquired from a tri-axial accelerometer fixed to the cow's hind leg. Together, these two technologies provide data on the most common behaviours displayed by individual cows when out on pasture.

Dairy cow with biting, chewing ruminating and movement sensors attached

When out on pasture, each bite a dairy cow takes is registered through the pressure sensitive noseband on her halter. By combining this output with that of the accelerometer on the halter using purpose-built software, biting, chewing and ruminating can be discerned. Another accelerometer on her hind leg registers changes in the movement of the leg in all directions. Based on this, walking, standing and lying behaviour can be discerned.

Although measuring individual behaviour is of great importance, each cow is also influenced by the behaviour of the rest of the herd, and its position within the herd hierarchy may be what determines if it performs well under a certain rotation regime. For instance, it may be that specifically low ranking cows have a hard time to graze enough if grass availability on a pasture becomes low, as they are chased away from the remaining spots of good grass by higher ranking cows. Such cows would likely walk more, graze less, and end up on the outskirts of the herd. For a complete assessment of such effects, positioning collars will be added to the mix to study (changes in) each cow's position relative to the rest of the herd and the pasture.

Future technology vision

AFBI is also currently assembling its ‘precision grassland platform’ that will pioneer the integration of the latest digital data capture systems into the management of each individual animal within herds at grass. This cutting edge research platform will integrate data on the animals as described above with automatically acquired sensor data on soil and grass characteristics described elsewhere in this booklet (see previous “AFBI Precision Grassland Platform” article in this booklet).

REARING AND FINISHING MALE DAIRY ORIGIN BEEF

Denise Lowe

Key messages

- Providing adequate colostrum reduces the need for antibiotic treatment and impacts positively on lifetime gain
- Low labour milk feeding stations can reduce labour by up to 60% with on implication for lifetime performance
- Dairy-origin bulls slaughtered at 16 months (versus dairy-origin steers at 26 months)
  - produce greater lifetime carcass gains
  - are more efficient at converting food to carcass gain
  - have lower feed costs perkg carcass gain
- There is potential to incorporate a grazing period for spring born dairy- origin bulls.
- Good quality grass silage can comprise 50% of the finishing diets for dairy origin bulls without compromising performance.

Background

A programme of research work has been ongoing at AFBI Hillsborough for a number of years that has focused on rearing and finishing male dairy origin beef. This has produced important findings that have been developed into a number of best practice principles for local farmers. This article briefly reviews the evidence and explains the key principles.

Research studies and findings

An adequate supply of colostrum is as important for dairy male calves as it is for female calves that are being kept as replacements. Results from previous studies at AFBI Hillsborough demonstrated that male calves with low immune status (indicated by Zinc Sulphate Turbidity (ZST) less than 20 units), required a greater number of antibiotic treatments in the pre-weaning period, had 17% lower live weight gains in the period up to 3 months, were on average 17 days older at slaughter and in monetary terms produced a lower margin over feed.

A study using 270 spring-born bull calves were sourced from 12 farms throughout Northern Ireland, allocated calves to either a low labour input regime involving feeding milk in groups once per day or a standard regime of feeding milk individually twice per day using buckets. This work showed that the low labour system reduced labour inputs by up to 60% relative to standard calf rearing systems, whilst producing similar lifetime performance.

A previous study indicated that keeping dairy origin bulls entire and slaughtering at 16 months of age produced greater lifetime carcass gains, was more efficient at converting food to carcass gain and had lower feed costs perkg carcass gain relative to dairy-origin steers slaughtered at 26 months of age. It should be noted that current market requirements dictate that bulls must be slaughtered as less than 16 months of age. In this study calves were allocated to one of four rearing/finishing regimes after weaning. The regimes included: bulls reared and finished on ad libitum concentrates (2.6 t of concentrates/head), bulls reared on forage (grass/grass-silage)/ concentrate-based system (1.7 t of concentrates/head), steers reared on a forage (grass/grass silage)-based system with either medium (1.5 t of concentrates/head) or low (0.8 t/concentrates/head) concentrate input. Rearing dairy-origin bulls on a forage/ concentrate-based diet reduced lifetime live weight gain and carcass value relative to bulls reared and finished on ad libitum concentrates. However, feed costs perkg carcass gain were lower, although the relationship depended on concentrate price. For dairy-origin steers, reducing concentrate inputs from 1.5 to 0.8 t per head and making best use of forage reduced lifetime performance and carcass value. However, feed costs perkg carcass gain were lower for the low concentrate input system which increased margin over feed costs. However, the differential between the two systems decreased as concentrate price increased.

A recent study at AFBI Hillsborough compared offering 212 day old bulls either an intensive diet of ad lib concentrates, supplemented with barley straw or a less intensive diet based on good quality grass silage, supplemented with moderate amounts of concentrates (capped at 6kg fresh/head/day). Prior to the commencement of the experiment, the bulls were grazed for 16 weeks and supplemented with 2kg of concentrates per day at grazing. Performance of cattle housed on concrete slatted floors for an average of 216 days from October onwards until slaughter are presented in Table 1.

Table 1. Performance of finishing dairy origin bulls from 212 days to slaughter

	Intensive diet ad lib concentrates + straw	Less Intensive Diet Grass silage + concentrates
Total concentrate input (t fresh)	1.85	1.13
Total silage input (t DM)	0.30	0.93
Total straw intake (kg DM)	97	0
Slaughter weight (kg)	525	521
Live weight gain (kg/d)	1.45	1.44
Age at slaughter (months)	15.5	15.6
Carcass weight (kg)	274	267

Bulls offered good quality grass silage supplemented with a moderate amount of concentrates had similar performance to those offered a high concentrate diet.

Farming guidance

This study highlights the scope for inclusion of forage in the diet of dairy origin bulls; both in utilising high quality grass and also good quality grass silage with a D value of 70 or above. It is important to carefully consider Health and Safety issues when keeping bulls entire, including having secure fencing and adequate handling facilities.

HOLSTEIN BULL BEEF PRODUCTION SYSTEMS

Naomi Rutherford and Francis Lively

Key messages

- Bull beef production normally involves intensive indoor systems, however the inclusion of a grazing period could reduce the cost of production
- Grazed grass can sustain growth rates of 0.9kg/d from autumn-born bulls
- Including grazed grass as part of the growth phase increased margin over feed by £50/head over traditional intensive concentrate rearing of Holstein bulls

Background

Bull beef production often involves an intensive indoor system, involving a high level of concentrate feeding. With feed costs accounting for up to 75% of the variable costs in beef production it is not surprising that profitability is determined by carcase output per hectare and the proportion of grazed grass in the diet. Grazed grass is the cheapest feed available for beef cattle. Thus, the inclusion of a grazing period during the first summer could help to reduce production costs.

Research study details

This study commenced in May 2017 and involved 56 autumn-born Holstein bull calves. Bulls were assigned to 4 different production systems which differed during the summer growing period:

1. Grazed with no concentrate supplementation (G-zero)
2. Grazed with 2kg/day concentrate supplementation (G+2kg)
3. Grazed with ad libitum access to concentrates (G-adlib)
4. Housed with ad libitum access to concentrates and silage (H-adlib)

Bulls were on average 6.5 months old at the beginning of this study. Bulls on the three grazing managements were rotationally grazed in 7 day paddocks, while the housed bulls on ad libitum concentrates were on slatted accommodation. All bulls were housed in the autumn and all were finished on ad libitum concentrates and silage. Bulls were weighed fortnightly and intakes were recoded daily throughout the study. Bulls were slaughtered at an average age of 15.5 months. The effect of production system on health, performance, carcase characteristics and cost of production was evaluated.

The overall aim of the study was identify if a grazing period could be included in Holstein bull beef production and if concentrate supplementation at grass was required.

Research findings

Bulls were able to achieve 0.90kg LW/d from a grass only diet. When grazed and given ad libitum concentrates, bulls performed the best during the summer grower period with a mean daily live weight gain (DLWG) of 1.67kg/d. Over the 6 month finishing period bulls that were grazed with no supplementation, had the greatest DLWG of 1.52kg/d hence exhibiting compensatory growth. However, those that were supplemented at grass with ad libitum concentrates, maintained their live weight advantage from housing through to slaughter at 622kg; and achieved a carcase weight of 320kg. Those restricted to 2kg/day concentrate while at grass, had the lightest carcass weight of 292kg.

Table 1: Performance and cost of production for autumn-born bulls on four production systems

Production system	G-zero	G+2kg	G-adlib	H-adlib
Start weight (kg)	196	196	196	196
Live weight at housing (kg)	279	299	346	339
Live weight at slaughter (kg)	579	579	622	602
Summer DLWG (kg/d)	0.90	1.15	1.67	1.59
Finishing DLWG (kg/d)	1.52	1.43	1.44	1.42
Average DLWG (kg/d)	1.38	1.34	1.52	1.48
Carcase weight (kg)	299	292	320	311
Kill out (%)	51.7	50.8	51.5	51.1
Confirmation grade A	4.46	3.91	4.29	4.38
Fat class B	7.69	7.91	8.14	7.31
Summer cost (£/d)	0.68	0.93	2.11	1.72
Finishing cost (£/d)	2.44	2.14	2.41	2.20
Production system costD (£)	532	534	672	614
Carcass value (£)	995	956	1061	1026
Margin over feed costs (£)	91	50	17	40

AScore 1-15 (1=P-, 15=E+) B Score 1-15 (1= 1-, 15=5+) C Based on a LW value of £1.90/kg
DFeed costs from 6 ½ months to slaughter at 15 ½ months
G-zero = Grazed/no concentrate: G+2kg = Grazed + 2kg/day concentrate:
G-adlib= Grazed + ad libitum concentrates: H-adlib = Housed + ad libitum concentrates

Production system had a substantial effect on feed costs during the summer period, with differences of as much as £1.43/day. However, it should be noted that a degree of spillage/wastage of concentrates around the creep feeder was observed; and therefore could result in an overestimation of intakes and summer costs for the bulls allowed ad libitum access to concentrates while at grass. Nonetheless, considerable savings can be made from increasing the proportion of grazed grass in the diet. Production system had less of an effect on finishing cost per day. During the finishing period the proportion of concentrate in the diet was similar for all bulls at 80% DMI. Overall, differences in production system resulted in a variation in the cost of production of up to £105. When carcass value and feed costs are considered bulls that were grazed without supplementation were the most profitable.

Farming guidance

There are opportunities to include a grazing period without concentrate supplementation and expect to achieve a higher margin over feed costs than previously expected. Reasonable LWGs can be obtained during the summer, and compensatory growth achieved during the finishing period. As a result, in the current study, a difference in carcass weight of only 12kg was observed between bulls housed on ad libitum concentrates and those on a grass only summer diet. Thus, the inclusion of a grazing period has the potential to significantly reduce production costs on farm, without causing a considerable detriment to performance.

Footnote: This project is funded by DAERA and AgriSearch

WHAT CAN BOVIS DO FOR YOU AS A DAIRY FARMER?

Francis Lively and Frances Titterington

Key messages:

- BovIS combines data from APHIS with carcass and post mortem data
- BovIS enables you to view how the cattle that are bred on your farm or slaughtered from your farm perform in the abattoir
- BovIS offers a suite of decision support tools that enable you to benchmark

What is BovIS?

The Bovine Information Service, BovIS, was developed by AFBI to offer Northern Ireland cattle farmers the information they need to help improve production efficiency and profitability of their farming business. There are two elements to BovIS, an integrated database which holds over 4.5 million records of cattle slaughtered in Northern Ireland since 2005, and an online information suite which provides tools for the producer to help inform management decisions. The database collates data from APHIS and seven of the largest abattoirs in Northern Ireland, which offers a valuable insight into production. In addition to industry analysis, BovIS offers a range of tools to help producers make informed management decisions. These tools, which are freely available for NI producers through the government gateway, offer exclusive access to information on the producers own cattle which have been slaughtered in BovIS abattoirs and the opportunity to benchmark performance against similar cattle and other breeds at both herd and Northern Ireland level.

BovIS in dairy beef production

Breeding dairy beef

The BovIS herd of origin report allows the producer to assess how cattle born on their farm have performed at slaughter, regardless where they were reared and finished. A simple search form allows the user to input a specific animal or a date of birth/ slaughter range (Figure 1) which will generate a report of the carcass characteristics of each of the individual cattle (Figure 2). This information can be used to inform management decisions, for example sire selection for the best performing progeny.

Figure 1: Simply enter the specific animal, kill date, birth date, breed or animal type of the cattle to obtain the finishing details.

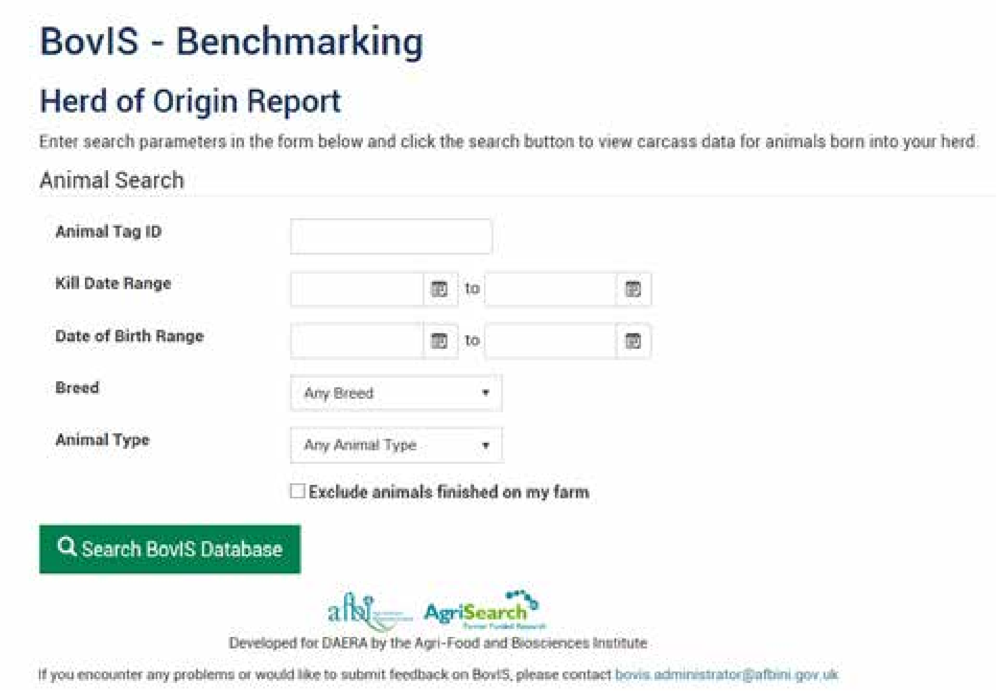
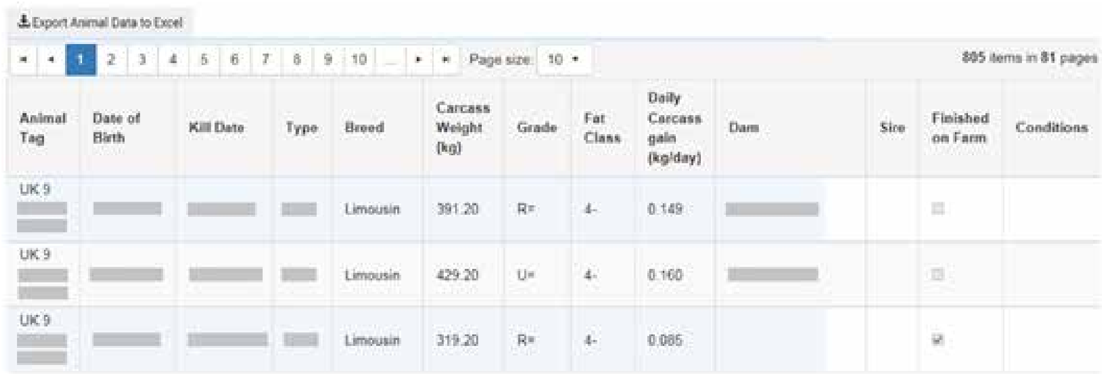


Figure 2: A report will be produced to show the cattle which fit the specifications selected in the "Animal Search" (Figure 1).


Export Animal Data to Excel

1 2 3 4 5 6 7 8 9 10 ... Page size: 10 — 805 items in 81 pages

Animal Tag	Date of Birth	Kill Date	Type	Breed	Carcass Weight (kg)	Grade	Fat Class	Daily Carcass gain (kg/day)	Dam	Sire	Finished on Farm	Conditions
UK 9 [redacted]	[redacted]	[redacted]	[redacted]	Limousin	391.20	R=	4-	0.149	[redacted]			
UK 9 [redacted]	[redacted]	[redacted]	[redacted]	Limousin	429.20	U=	4-	0.160	[redacted]			
UK 9 [redacted]	[redacted]	[redacted]	[redacted]	Limousin	319.20	R=	4-	0.085			✓	

Finishing dairy beef or cull cows

BovIS offers a target driven growth curve which allows the producer to compare cattle weights to a target for the selected age. The user simply selects a date of birth range and animal category. The animal category can be dairy or suckler herd replacements, or dairy beef (Figure 3). The application will then present all of the animals which are in the specified category and date range that was in the herd on the date of weighing, and the user can input the weight for each animal. The tool then generates a table of individual level performance and a chart showing group performance relative to the target and provides the daily live weight gain required to achieve the desired target in 3 months' time (Figure 4). Not only does this provide the most efficient way to achieve production targets such as calving replacements at 24 months or producing dairy origin beef, but the breakdown of individual performance means that poor performers can be identified and separated if necessary.

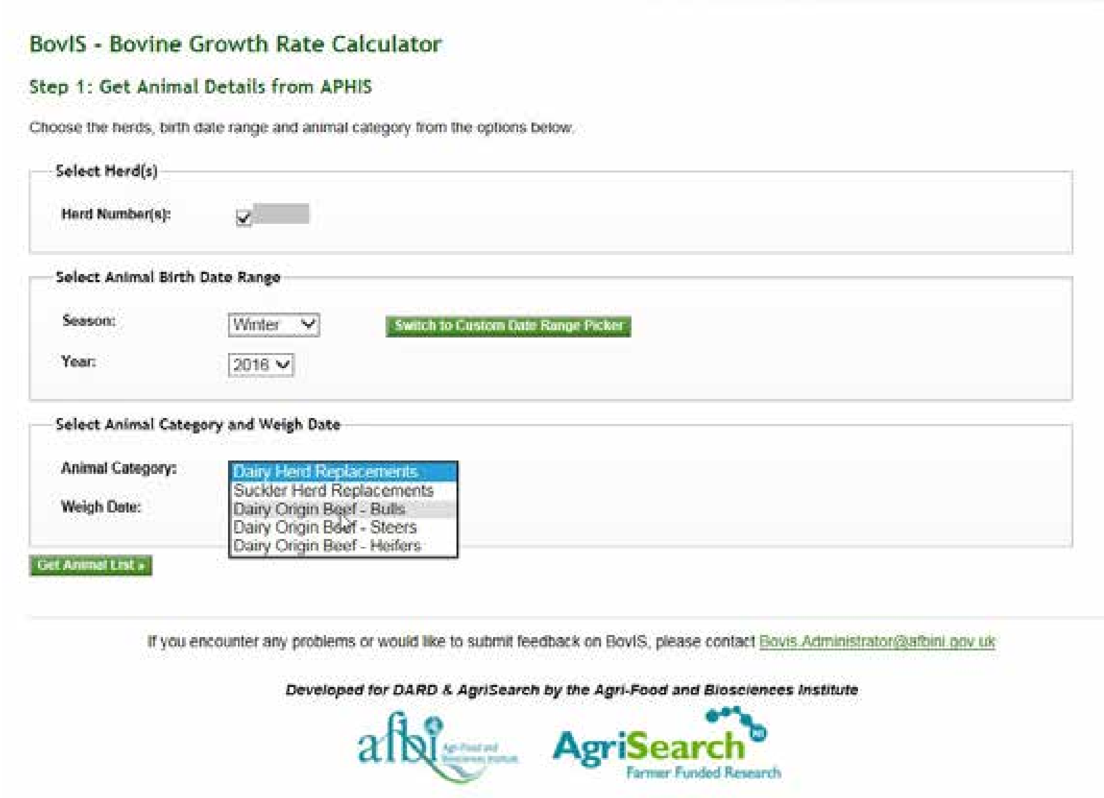
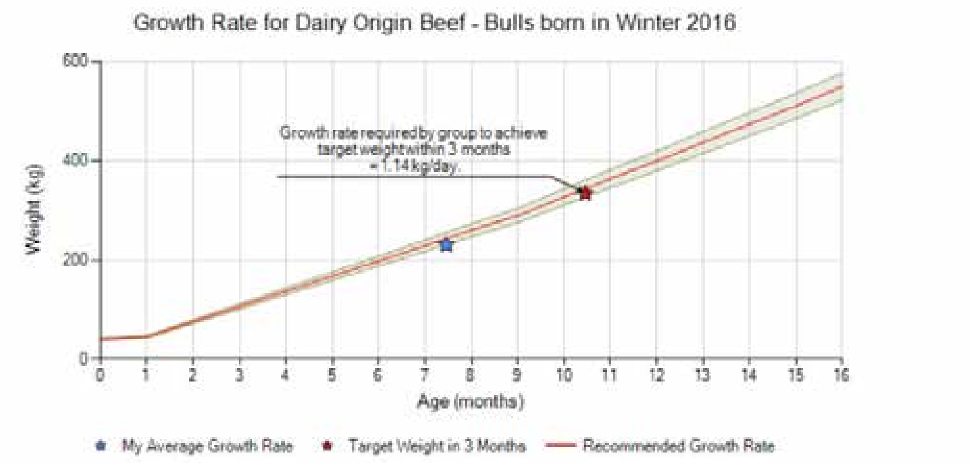


Figure 3: Select the birth date range and system required. All cattle in the herd which match this criteria will be automatically gathered from APHIS



Dairy Origin Beef - Bulls born in Winter 2016

Animal Tag No	Sex	Breed	Date of Birth	Age (months)	Weight (kg)	Target Weight (kg)	Target Weight in 3 Months (kg)	Target Live Weight Gain (kg/day)
UK 9	B	Holstein	17/01/2017	7.6	255	260	364	1.19
UK 9	B	Holstein	21/01/2017	7.5	230	229	327	1.06
UK 9	B	Holstein	24/01/2017	7.4	222	229	327	1.15
UK 9	B	Holstein	24/01/2017	7.4	226	229	327	1.11
UK 9	B	Holstein	24/01/2017	7.4	219	229	327	1.18
			Average:	**7.5**	**230**	**235**	**334**	**1.14**

Note: It may not always be physically/practically possible to achieve stated growth rate within 3 months. Please consult with your CAFRE Development Advisor.

Figure 4: An example of the growth chart and table produced by the growth monitoring tool. This allows management at both a group and individual level

Other BovIS tools

Carcass benchmarking tool

Easily access the records of your cattle which have been slaughtered and generate reports to show their average weight, age and carcass characteristics. The benchmarking tool offers the opportunity to compare between different breeds, time periods both within your herd, all cattle slaughtered in Northern Ireland, and the best performing ten percent of herds. This tool has been designed to allow the producer to identify which breeds are most efficient in your production system and to benchmark against other producers

Ante Mortem/ Post Mortem tool

The results of ante mortem (AM) and post mortem (PM) meat inspections is already available on APHIS, however the new AM/PM BovIS tool offers an easily accessible breakdown of disease incidence on farm. This allows comparison with disease levels at both national and local levels. This information allows the producer to identify problems within the herd and adjust management or provide useful evidence to their vet to develop tailored treatment plans.

In spec tool

The in spec tool was developed in conjunction with the LMC to provide a detailed overview which allows the producer to select the market requirements for their cattle. Using these specifications, the tool allows the producer to find out if their cattle achieve the desired carcass characteristics and if not, where they can improve. This tool also offers an innovative calculator which determines the financial impacts of not achieving the market specification criteria and the potential financial impacts of changing management to meet the market specification.

Green House Gas calculator

Producing agri-food in an environmentally responsible manner is critical for the industry. The Greenhouse Gas (GHG) calculator allows the producer to calculate the carbon footprint of their farming operation with a few simple outputs, ensuring best practice and identification of where efficiencies can be made.

Future developments

BovIS tools will continue to evolve and new applications will be developed to further assist producers in making informed management decisions. If you have any questions about the BovIS database or online tools, please contact your local CAFRE advisor or email: BovIS.Administrator@afbini.gov.uk

BovIS
Bovine Information System

(BovIS logo for branding within the booklet).

AFBI'S EASY-TO-USE BOVIS CARBON CALCULATOR FOR DAIRY FARMS

Aurélie Aubry, Steven Morrison, Tianhai Yan and Conrad Ferris

Key messages

- Efficient farming irrespective of system reduces the carbon footprint per litre of milk produced
- AFBI developed online GHG calculator allows producers to estimate the carbon footprint of their dairy enterprise and identify areas for improvement

Background

Increasing concerns about the impact of climate change have focused the attention of government and policy makers on the need to develop accurate estimates of greenhouse gas (GHG) emissions from key sectors. This is particularly true within the United Kingdom where the UK Climate Change Act requires an 80% reduction in GHG emissions by 2050, relative to 1990 emission levels. Achieving these ambitious reduction targets will require a significant effort across all sectors.

Within the agricultural sector, dairying in particular makes a significant contribution to total GHG emissions, with dairy farming worldwide estimated to contribute 30% of the total of global agricultural emissions. This highlights the need for the dairy industry to accurately quantify its emissions, and to identify strategies by which these can be reduced.

Carbon footprint of milk production in Northern Ireland

Results from a carbon footprinting study conducted by AFBI and involving Farm Business Survey (FBS) data from 1990 and 2014 show that while the agriculture sector has made relatively modest progress in reducing total Greenhouse Gas emissions (5.2% reduction since 1990), dairy farming has made substantial progress in reducing its emissions on a per unit of production basis (30.7% reduction since 1990). A major reason for this improvement is that Northern Ireland has experienced continual growth in its total milk production over the period (67% increase since 1990) which was driven primarily through increases in milk yield per cow.

However milk yield is not the complete story. Production efficiency, more than the specific production system itself, is the key determinant of the carbon footprint of milk production. AFBI research calculated the carbon footprint of a high concentrate input total confinement system and compared it to a medium concentrate input grazing system involving either Holstein-Friesian or cross-bred (Jersey × Holstein-Friesian) cows. Total emissions allocated to milk production were 36% greater for the confined cows due to higher emissions related to dietary concentrate supplementation, manure management and enteric fermentation. In contrast, total emissions perkg of energy corrected milk (ECM) were similar with both systems (1.04 and 1.03kg CO_2e/kg ECM, respectively). Total emissions from Holstein-Friesian cows, when confined, were 9% higher than from the cross-bred cows, reflecting higher milk yields, intakes and replacement rates with the former. In contrast, emissions perkg of ECM were 3% lower with Holstein-Friesian cows than with the cross-bred cows, when confined. This was a consequence of the poorer response of crossbred cows to concentrate supplementation. Generally, the results demonstrate that the carbon footprint of contrasting milk production systems can be very similar provided the most efficient breed is used within the system.

BovIS carbon calculator for dairy farms

Through DAERA and AgriSearch funding, AFBI has developed the BovIS carbon footprint calculator to assist the dairy industry in quantifying and reducing its GHG emissions. This calculator, currently available through DAERA Online Services, has been independently verified against international standards (PAS 2050; International Dairy Federation) and enables Northern Ireland's dairy producers to calculate the quantity of GHG emissions per litre of milk produced. The easy-to-use calculator accounts for all activities within a farm that are sources of GHG emissions, such as emissions from rumen fermentation, manure management, fertiliser manufacture and application, and concentrate production and transportation.

How does it work?

A simple online questionnaire completed by the producer enables the calculator to produce a summary report which shows the emissions produced by each part of the farming activity. Through calculating their carbon footprint, producers can investigate ways to reduce the GHG emissions from their dairy enterprise. Figure 1 shows the footprint of a dairy system that is using a typically moderate concentrate level for Northern Ireland. The carbon footprint of this system was calculated to be 1085 g of CO_2e/kg milk (blue bar in Figure 1), with over 50% coming as methane production from enteric fermentation. Fertiliser usage was the second largest source of emissions, particularly as this includes emissions during manufacturing and transport as well as losses on the farm. The third highest source of GHG emissions was from manure, which was at a relatively similar level to the applied fertilizer. Carbon sequestration by permanent grassland locked-up approximately 18% of the GHG emissions produced by the farm (green bar in Figure 1), therefore reducing the overall footprint.

Through understanding the farming system, potential GHG mitigation strategies can be explored. Using this moderate input farm as an example, reducing the age at first calving from 27 to 24 months of age reduced the overall dairy GHG footprint by 7%. This reduced footprint was a result of fewer heifers in total on the farm which also meant that less land, forage, fertiliser and meal was required. A number of potential GHG emission reduction strategies are shown in Table 1 with detailed descriptions provided to many of these within the Greenhouse Gas Reduction Strategy and Action Plan.

Farming guidance

Reducing greenhouse gas emissions is a complex relationship between soils, livestock, environment and farm management but fortunately lower GHG emissions are generally linked to improved production efficiency and profitability. Therefore producing milk efficiently will have positive effects on the GHG emissions from the Northern Ireland dairy sector. By routinely using the AFBI developed BovIS calculator producers can now:

(i) calculate the quantity of GHG emitted from their farm per litre of milk produced

(ii) examine the effect of adopting management changes on the carbon footprint of their farm.

Figure 1 The Greenhouse gas footprint of a moderate input Northern Ireland dairy system

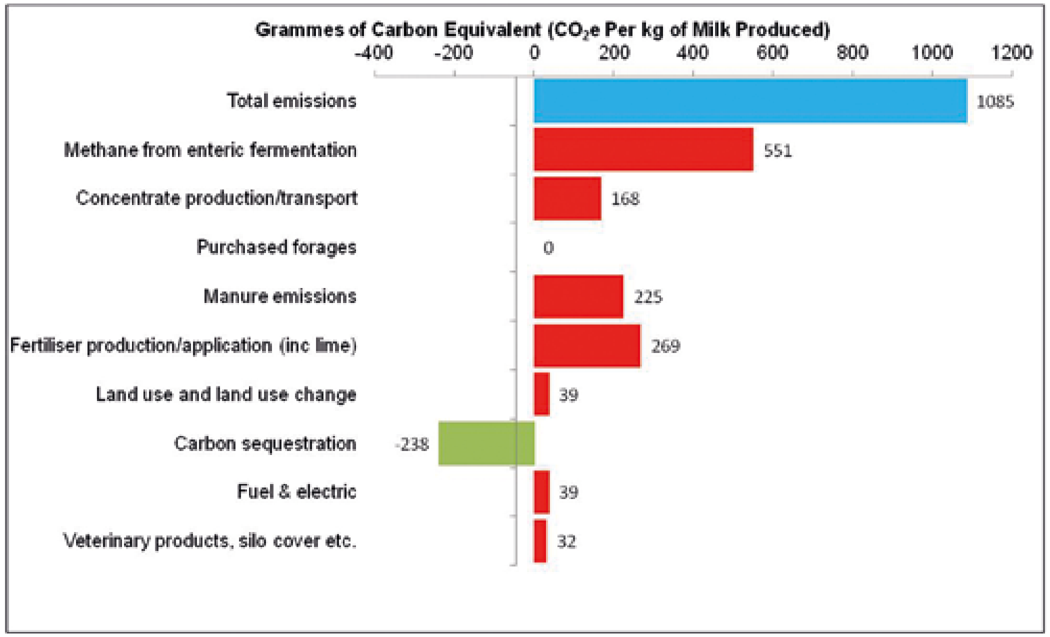


Table 1 Potential Greenhouse gas reduction strategies

Examples of potential greenhouse gas reduction strategies within dairy production systems
Nutrient management planning and timing / application of slurry
- Matching nutrient supply to crop requirements
- Low emission slurry spreading techniques such as trailing shoe/shallow injection
- Time of slurry and inorganic fertiliser application relative to weather conditions
Genetic Improvement
- Breeding cows with increased milk solids output and increased longevity
Improved feed efficiency
- Nutritional analysis of feeds to formulate diets to meet animal demands
- Batching of cows to allocate feed more effectively
- Production and utilisation of high quality grazed grass and grass silage
Improved animal health
- Herd health planning to control/eradicate infectious diseases e.g. BVD
On-farm energy efficiency
- use of more energy efficient equipment such as high efficiency milk pumps and plate coolers
- regularly service dairy/farm equipment to minimise fuel/electric use
Others
- Reduce age at first calving to 24 months; feed low carbon footprint by-products; use of renewable energy sources; use of grass/clover swards

MAKING THE MOST OF NUTRIENTS IN SLURRY AND DIGESTATE

Gary Lyons and Chris Johnston

Key messages

- Cattle slurry and digestate contain valuable nitrogen, phosphate and potash
- Many dairy farms have phosphorus surpluses and spread more than their grass requires
- N content of digestate is on average 19% greater than the slurry it was derived from
- 1kg of slurry N is equal to 0.35kg fertiliser N, but 1kg of digestate equates to 0.40kg N

Background

Dairy cattle slurry and digestate are valuable sources of nitrogen (N), phosphate (P_2O_5) and potash (K2O). Making efficient use of these 'organic' nutrients can appreciably lower the need for expensive 'chemical' fertiliser and improve farm profitability. Furthermore, because chemical fertilisers are produced using fossil fuel energy, minimising the amount brought onto farms will also reduce the farm 'carbon footprint'. However, despite P_2O_5 fertiliser use having declined in recent years, the use of P-rich concentrates for milk production has continually increased. Hence many dairy farms have large phosphorus (P) surpluses, in some cases spreading over 20kg P/ha more than required by the grass. These P surpluses pass into animal excreta and from there onto land, and as a result, more than 50% of grassland soils on dairy farms have P indices greater than index 2+ - the agronomic optimum. Some of this excess soil and manure-P is being washed into streams and rivers thereby hindering Northern Ireland (NI) from meeting chemical water quality standards under the EU Nitrates and Water Framework Directives. Post Brexit, if Northern Irish milk products are to be competitive within the European market, they will need be produced cost-effectively and in compliance with strict environmental standards. It is critical therefore that action is taken to maximise the efficiency of on-farm nutrient sources (slurry and digestate) for grass and hence milk production, and to reduce the large P surpluses existing on many dairy farms.

This article describes some of the research conducted by AFBI that has defined the potential value of appropriately used slurry and digestate on farm and describes new research that is seeking to develop practical methods of reducing nutrient loading on farms

Making the most of slurry N

Cattle slurry contains approximately 50% organic N (not readily available for crop production) and 50% ammonium N, which is assumed to be 100% available to plants following application. However, up to 90% of this available N can be lost to the atmosphere through volatilisation following slurry spreading. AFBI research has shown that applying slurry using trailing shoe to reduce ammonia losses to the atmosphere, offers most of the benefits of injection, without many of its drawbacks. Results of AFBI research show that across the growing season, applications of cattle slurry alone (34 m^3/ha/cut) by trailing-shoe produced 1.5 tonnes more grass dry matter (DM) compared to similar applications of slurry using inverted splash plate. Trailing shoe was always better than splash plate, but the difference was less marked in applications for the 3rd harvest. Results of the research clearly show that the efficiency of slurry N for grass silage production is highest when applied in spring for 1st cut crops, and appreciably lower when applied for 2nd and 3rd cut crops (Figure 1).

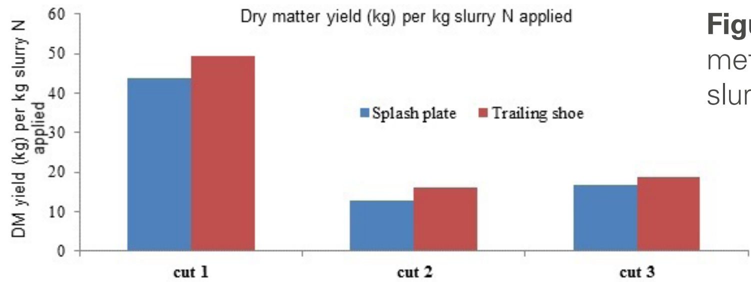


Figure 1. Effect of timing and method of slurry application on slurry nitrogen use efficiency

How does digestate compare to slurry as an available N source?

Research on anaerobically digested dairy cow slurry at AFBI Hillsborough has shown that the available N content of digestate is on average 19% greater than that in the slurry feedstock (2.10kg N/t compared to 1.78kg N/t); the DM content of which is also 20% lower. The research also indicated that on average 1kg of slurry N is equivalent to 0.35kg fertiliser N (CAN), whereas 1 kg of digestate N is equivalent to 0.40kg fertiliser N, which is an increase of 14%. Consequently. field experiments have shown that digestate can increase DM yield of grass by 16% compared to similar rates of slurry, and with a 15% increase in the nutrient value per tonne applied.

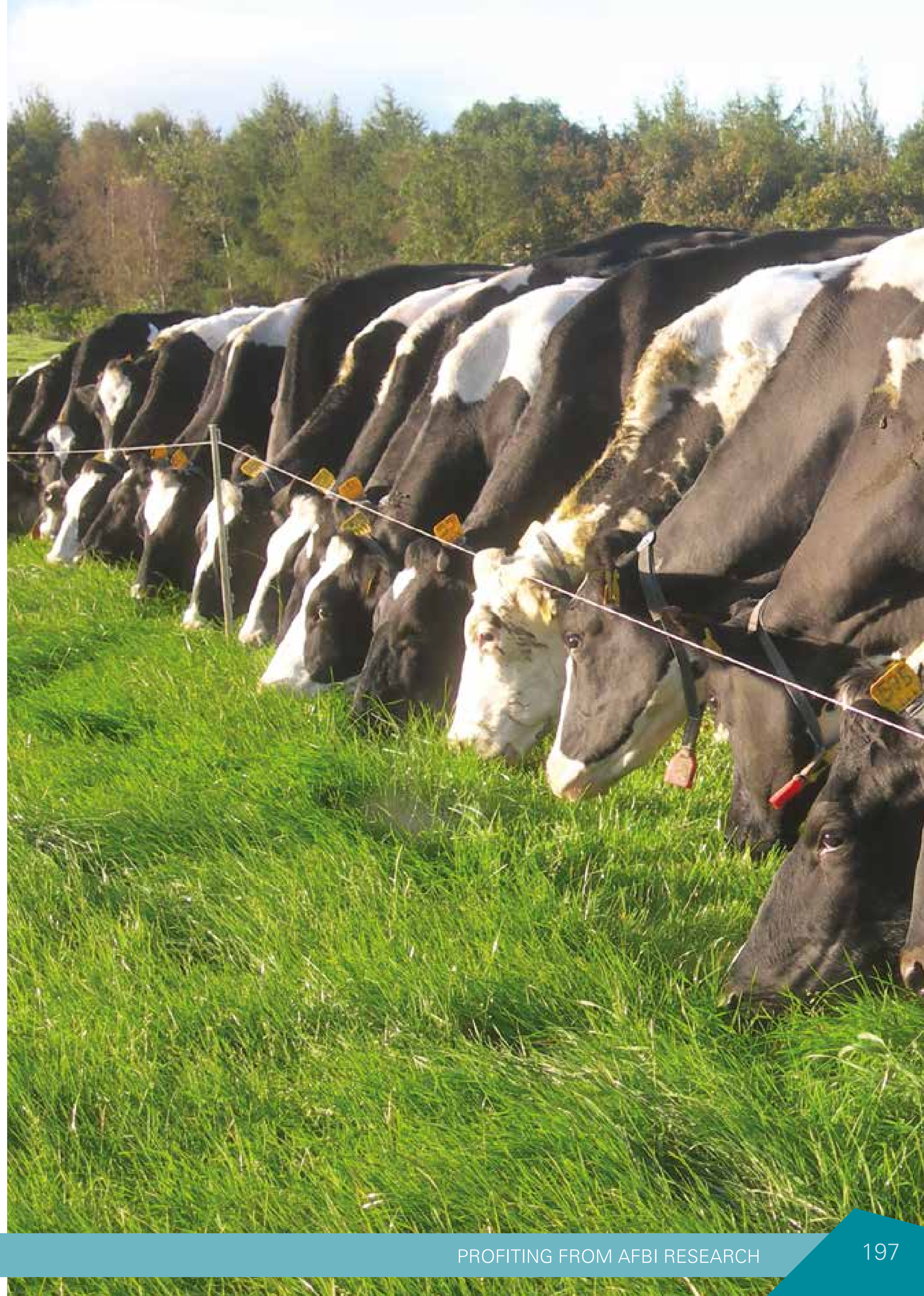
New AFBI research facilities and studies

Slurry and digestate separation: a key to managing surplus phosphorus

A strategy to minimise environmentally damaging effects of surplus phosphate, is to reduce the amount in slurries and manures prior to land application. Such enhanced nutrient management on-farm could be critical to prevent soil P levels increasing and to reduce the risk of P loss to water. For this reason AFBI has installed a new Nutrient Management Centre containing screw press and centrifuge technologies to treat animal slurries and the digestate coming from the on-site anaerobic digester. This has opened up new research opportunities to improve nutrient management on farm.

The ability to partition the P in slurry and digestate to a liquid and a solid fraction using mechanical separation, is of considerable benefit. The liquid fraction has a lower concentration of P than the solids fraction, and contains valuable N and potash which can be spread as organic fertiliser to more precisely match grass nutrient requirements without exacerbating the P over-supply problem. The separated solid fraction may be further processed (dried, composted or granulated) to produce a saleable, stable, low moisture product that could then be exported off-farm to facilitate P-balance reduction and lower run-off risk. This new area of research will help develop more effective nutrient recycling practices that will be expected to enhance the economic and environmental performance of the NI dairy industry.

AFBI's Anaerobic Digester and Nutrient Management Centre, Hillsborough.



AMMONIA AND DAIRY FARMING

THE NORTHERN IRELAND PROBLEM

Graham Finney and Tianhai Yan

Key messages

- ammonia from livestock manures leads to negative environmental consequences
- ammonia emitted from our dairy farms is deposited back on land locally as nitrogen
- ammonia deposition can reduce biodiversity, acidify soils and modify ecosystems
- the release of ammonia is a cost to the farmer through the loss of a valuable nutrient

Background

AFBI works with key stakeholders and policy developers throughout Northern Ireland to both support a sustainable dairy industry and to protect and improve the environment. However, there are occasions when delivering against both simultaneously, can be a challenge.

A current example has arisen in relation to ammonia emissions from Northern Ireland agriculture. This has become a topical issue recently with many planning applications for farm development requiring assessment to identify the impact of ammonia emissions on nature.

Issues with livestock ammonia emissions is a long standing problem. Just how long came to light in a recent DEFRA 'Ammonia in the UK' publication that highlighted the statement below, made by Arthur Young, the 18th century agricultural pioneer. Perhaps without realising it, he had identified and defined the problem of ammonia emissions.

"He who is within the sphere of the scent of a dunghill, smells that which his crop would have eaten, if he had permitted it. Instead of manuring his land, he manures the atmosphere; and before his dunghill has finished turning, he has manured another parish, perhaps another county." Arthur Young (1741 - 1820)

Ammonia: What is the issue?

Ammonia is a soluble reactive gas containing nitrogen and is a component of animal waste which is generated in the cycling of nitrogen during storage, on housing floors and in the rural environment after spreading. Agriculture and food production depend upon this cycling, however the resulting ammonia from livestock manures and the application of fertiliser can lead to negative environmental consequences.

Unlike Greenhouse Gases which impact on a global scale, the repercussions from ammonia emissions are localised. So the ammonia emitted from our dairy farms is deposited back on land locally. These deposits can have extremely negative consequences for plant species that are adapted to low nitrogen concentrations, most notably within the designated sites and priority habitats which represent our most sensitive and environmentally important species and areas. In these areas, the excess nitrogen results in vulnerable and sensitive species being effectively outcompeted by other, more nitrogen-tolerant species, thus causing environmental damage through biodiversity loss, soil acidification and changes in ecosystem structure and function.

As well as potentially damaging the environment, the release of ammonia is a cost to the farmer through the loss of a valuable nutrient. Nitrogen is a key farm input bought in through fertilisers and feedstuffs to support production and profitability. Under-utilisation of nitrogen effectively wastes the financial investment the farmer has made. Livestock feeding systems are important because currently, only about 20-40% of the protein- nitrogen in the livestock diet is later found in the animal or animal products (such as meat and milk) and the rest is excreted in dung and urine. The priorities should therefore be to (a) make sure that animals are not fed more protein than they need, and (b) utilise nitrogen effectively and retain it within the animal.

AMMONIA AND DAIRY FARMING

THE FACTS AND NEW AFBI RESEARCH

Graham Finney and Tianhai Yan

Key messages

- Twelve percent of the total UK ammonia emissions arises within Northern Ireland
- Over 90% of ammonia emissions in Northern Ireland are from agriculture, with cattle farming responsible for over 70%
- AFBI is conducting a 4-year DAERA research programme to identify and test dietary factors which could reduce dairy cattle nitrogen excretion and lower ammonia losses

Background

Agriculture is the dominant source of ammonia emissions in Northern Ireland, across the UK and throughout the world. Current inventory figures show that 12% of total UK ammonia emissions are within Northern Ireland. A total of 91% of all ammonia emissions from Northern Ireland in 2015 came from agriculture, and cattle production was responsible for over 70%. This demonstrates that the solutions for addressing the environmental impact of ammonia must come from agriculture, of which dairy farming is a major contributor.

However, opportunity to improve these inventory figures has been identified by adopting an approach which would more fully take into account the variety of farming conditions specific to Northern Ireland. This approach has worked well previously. For example, in the development of the Nitrates Action Programme for Northern Ireland, dairy cows in Northern Ireland were found to have a lower excretion of nitrogen than dairy cows in GB. A second example relates to floor types in cattle houses. Cattle in Northern Ireland are mainly housed in slatted floor-based accommodation. There is some evidence that suggests that cattle managed under slatted floor systems produce less ammonia than those on solid floor systems but this needs to be explored further and ultimately the appropriate emission factor for slatted floor systems needs to be established.

Recommendations

The Expert Working Group on Sustainable Agricultural Land Management for Northern Ireland released a report in 2017; "Making Ammonia Visible". This report explicitly discussed the ammonia problem and concluded with a number of recommendations for Northern Ireland.

The first set of recommendations aims to "make ammonia emissions visible" and is concerned with improving our understanding of the effects of ammonia emissions and raising awareness of the problem.

The second series of recommendations is concerned with "optimising the evidence base" and advocates specific scientific work to produce more accurate local ammonia emission factors as well as quantifying the effects of different management strategies on ammonia emissions.

The final two sets of recommendations give advice to farmers and industry so that they can make informed decisions ultimately leading to reduced ammonia emissions for Northern Ireland agriculture.

New AFBI research

In order to address these problems for Northern Ireland, AFBI has recently embarked on two 4-year research programmes funded by DAERA. Through a range of experiments which, crucially will be representative of local agricultural systems, AFBI will identify and test dietary factors which could reduce the amount of nitrogen excreted by dairy cattle. This includes improving nitrogen utilisation efficiency with the specific aim to reduce urine nitrogen output since the greatest contributor to ammonia emissions is the volatilisation of urea from urine.

Since, at present, there is no robust information available on the ammonia emission factors for certain floor systems with cattle, AFBI will also investigate slatted flooring (as Northern Ireland's most common housing system) in comparison with solid flooring.

This will deliver new scientifically grounded emission factors to underpin government policy and advise farmers. In order to deliver reliable and repeatable advice, AFBI is currently developing a controlled closed system to remove the atmospheric variation inherent in naturally ventilated cattle housing.

AFBI, in collaboration with Rothamsted Research and the Centre for Ecology and Hydrology, will also model the impact of the on farm ammonia reduction measures recommended in the 2017 report by the Expert Working Group on Sustainable Agricultural Land Management for Northern Ireland. The economic impact of these recommendations will be assessed and the benefit of updating Northern Ireland's ammonia emission factors will be included in the assessment.

Farming benefits

In the coming years AFBI will be making a significant contribution to the challenge of bringing the dairy sector ammonia emissions under control whilst supporting sustainable and expanding enterprises. In so doing, future practices will not only benefit the environment but also improve nitrogen efficiency on dairy farms and so profitability.

AGRISEARCH

SUPPORTING PROFITABLE SUSTAINABLE DAIRYING IN NORTHERN IRELAND

Key Messages

- AgriSearch is an independent organisation whose purpose is to help make the Northern Ireland ruminant livestock sector become more competitive, profitable and sustainable.
- The value of the outputs of AgriSearch to farmers is many times greater than the levy investment
- A wide range of resources are available on our website www.agrisearch.org
- By applying the findings of AgriSearch co-funded research the average dairy farmer could potentially cut their milk production costs by around 5 pence per litre

What is AgriSearch?

AgriSearch (The Northern Ireland Agricultural Research and Development Council) is an independent charity. It was formed in 1997 to help beef, sheep and dairy farmers become directly involved with production-oriented research and development and to ensure a continuation of government funding for such research. Our mission is to drive profitability and sustainability of the ruminant livestock sector. We do this through funding and commissioning research directly applicable on farms to farmers. AgriSearch welcomes innovative ideas and identified needs for research that may solve problems. Farmers are involved throughout our decision-making processes. We are an independent organisation (separate from AFBI) governed by a Board of Trustees (who are directors of a Company Limited by Guarantee and registered with the Charities Commission for Northern Ireland).

The value of the levy investment

Northern Ireland's dairy industry needs to continuously improve technical efficiency to remain in business. At AgriSearch, we aim to provide the current and next generation of dairy farmers with the research based knowledge they will need to build efficient, sustainable and profitable farming businesses which can help them compete in a global marketplace. To achieve this AgriSearch works with research organisations and industry bodies across Europe bringing innovation to Northern Ireland.

A review of AgriSearch co-funded research carried out in 2006 showed a 22:1 return on farmers levy, assuming adoption rates of between 5 and 10% for the various recommendations arising from the research.

AgriSearch has been heavily involved in funding a wide range of dairy research activities spanning subjects such as heifer rearing, dairy cow nutrition, improved grassland utilisation and dry cow management.

With levy investments of around £400,000 per year over the past 20 years we have been able to play a key role in large scale research projects co-funded by more than £43 million of contributions from industry organisations, government and international bodies. This collaboration has brought considerable benefit to Northern Ireland farmers. Much of the 'cutting edge', independent research is generated within Northern Ireland at AFBI Hillsborough and on farms of co-researchers.

In addition to the potential gains to be made from applying the findings of research conducted under Northern Ireland conditions, one direct financial payback of the data collected under the "GrassCheck" programme was that Northern Ireland was able to obtain £4.57M in 2002 for 'weather aid' payment. This source of data was also used to provide a business case for the 2013 fodder transport scheme, which brought aid of £1M to the qualifying farms in Northern Ireland. The 2002 aid alone is equivalent to more than 10 years of AgriSearch levy income.

AgriSearch co-funded research has been pivotal in getting the best outcome possible under the Nitrates Directive. Results of this research were used to establish the 91kg manure N emissions standard figure for Northern Ireland dairy cows. This is around 10% lower than the figure used in GB, allowing Northern Ireland farmers a higher stocking rate. This is estimated to be worth £5.4M per annum. More recent research has been vital in ensuring that Northern Ireland farmers are permitted to continue to spread slurry in February and in providing the scientific case to allow for the nitrates derogation to be renewed for a further four years in Northern Ireland.

It should also be noted that the on-farm BVD prevalence study which was led by AgriSearch provided the business case for Animal Health and Welfare Northern Ireland's BVD eradication scheme. Research carried out into the diagnosis of Johne's disease has also been incorporated into AHWNI's Johne's control programme.

Pioneering on-farm research

- Together with their research partners at AFBI, AgriSearch has pioneered the use of on-farm research. Key benefits for both farmers and scientists include:
- Much greater numbers of animals, leading to more robust data
- Range of genetics, environments and farm management systems
- First-hand farmer experience

These on-farm research projects often involve industry partners who bring knowledge and experience to the project as well as other in-kind contributions of products and services.

Omagh dairy farmer Drew McConnell who has been involved in a number of on-farm research projects explains the value of on-farm research.

As a commercial dairy farmer, getting involved with a range of AgriSearch funded on-farm trials over the years has proved hugely beneficial to my own business. In 2008, we were part of a heifer rearing trial exploring the benefits of two-year old calving to Northern Ireland farms.

From this we began monitoring heifers more closely making sure they met targets for live weight at key stages such as weaning and mating to achieve two-year-old calving. This has resulted in better cow longevity, lower replacement rates and now an increased average lifetime performance to nearly 50,000 litres per cow, almost double the Northern Ireland average (Table 1).

Table 1. Benefits of adopting the latest heifer rearing research on farm

	NI Average	McConnell Herd
Age at first calving (months)	29	24.6
Lifetime productivity (litres / cow)	25,000	49,500
Rearing cost (£/cow)	1,957	1,478
Replacement cost (ppl)	6.0	1.9

Similarly, substantial cost savings have been achieved by altering our dairy cow diets after getting involved in an AFBI-AgriSearch study on transition cow management. This project which focused on reducing protein content in dairy cow diets in early lactation, made me aware of the potential gains to be achieved from lowering dietary crude protein whilst improving cow performance. The study crucially provided me with a sound, independent, evidence base that gave me confidence to make this change on my farm. In addition to the improved fertility and body condition score of the cows this has reduced feed costs by £50 per cow.

I would encourage all dairy levy payers to look closely at AgriSearch's past and ongoing dairy research projects and consider how you can adopt these findings on your farm.

Looking to the future, research will be the most important tool that we as farmers can use to help us meet the challenges of Brexit, increased demand for dairy produce and the need to deliver sustainably produced food. Help us make the most of your levy by bringing forward ideas for new research and getting involved in AgriSearch on-farm trials, ensuring we provide a sustainable and profitable future for Northern Ireland dairying.

How is it funded?

AgriSearch is funded by means of a voluntary levy collected by dairy and red meat processors. The levy rate for dairy is 0.02 pence per litre of milk. This amounts to £1.60 per lactation for an 8,000 litres dairy cow.

Who makes the decision on how the dairy levy money is spent?

Research projects are recommended for funding by Sectoral Advisory Committees (Dairy, Beef and Sheep). These are composed mainly of farmers along with a processing representative and an independent scientific expert. Stewardship of AgriSearch resides with the Board of Trustees. The guiding principles behind all AgriSearch projects are that they will provide research which will be of practical benefit to farmers and provide them with tools to help reduce costs, increase performance, drive innovation and improve welfare and environmental sustainability.

Why should farmers fund research, should the government not fund it all?

Government still does fund a considerable amount of research. Understandably this tends to focus on evidence needs for guidance of policy makers. However, by the industry being willing to commit some contribution of money and by making the case for particular projects, we are able to 'lever' government funding from the available budget to commission research. In the financial year 2015/16, for every £1 committed to research projects by AgriSearch there was a further £11 obtained from other sources.

There have been very significant changes to research funding mechanisms over the past seven years. Across all funding streams there is a requirement for active industry involvement and leadership. Collaborative projects are becoming more common and this trend is likely to continue.

In circumstances where AgriSearch's levy income on its own will not go far in payment for research, the real value of AgriSearch is the industry engagement it can bring and represent in a project, particularly the ability and experience in facilitating on-farm research.

Conclusion

AgriSearch's primary focus is to provide a return to Northern Ireland's dairy, beef and sheep farmers for the levy investment they put in. Reviews have estimated that return to be between 20 to 1 and 40 to 1 (based on 5 to 10% adoption rates).

AgriSearch provides farmers with the latest research and knowledge to help them improve technical efficiency. By applying the findings of AgriSearch co-funded research an average dairy farmer has the scope to cut their milk production costs by around 5 pence per litre.

AgriSearch provides a means for farmers to have a voice and role in research projects, the findings of many of which will inform government policy in the future as well as providing farmers with the tools and information needed to compete in an ever-changing world.

Get the most out of your levy by engaging with AgriSearch, bring forward questions / research needs and use the information available on the website www.agrisearch.org

Agri-Food and
Biosciences Institute

www.afbini.gov.uk @AFBI_NI