Focus Areas - Section 5

Nutrition

Dairy Heifer Rearing

Gillian Scoley

Good colostrum management provides the best start for your future herd

Key Messages

- Colostrum is the essential first feed for the calf as it is the only way for it to receive antibodies from the dam
- Poor quality colostrum increases the risk of failure of passive transfer – test colostrum quality routinely!
- Feed 3-4 litres of colostrum within a maximum of 6 hours of birth using clean feeding equipment

Background

Calves are born without a functioning immune system and rely on antibodies found in colostrum to prevent disease in the first weeks of life. Colostrum is the only source of these antibodies, so it is essential that they receive around 3-4 L of good quality colostrum as soon as possible after birth, ideally within 2 hours. The calf's ability to absorb antibodies 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.

Good quality colostrum should contain at least 50 g/L immunoglobulin G (IgG), which can be tested using a brix refractometer where a reading of 22% is equivalent to 50 g/L IgG. 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) which is a known factor for increased levels of morbidity and mortality in early life. The transfer of passive immunity from dam to calf via colostrum is considered adequate when the IgG concentration in calf serum exceeds 10 mg/ml in the first few days after birth.

Research Studies

In a study carried out by AFBI, farm management information was collected on 17 commercial dairy farms across Northern Ireland. Each farm collected colostrum samples from 20 dams immediately after calving and analysed for IgG content, an indicator of colostrum quality.

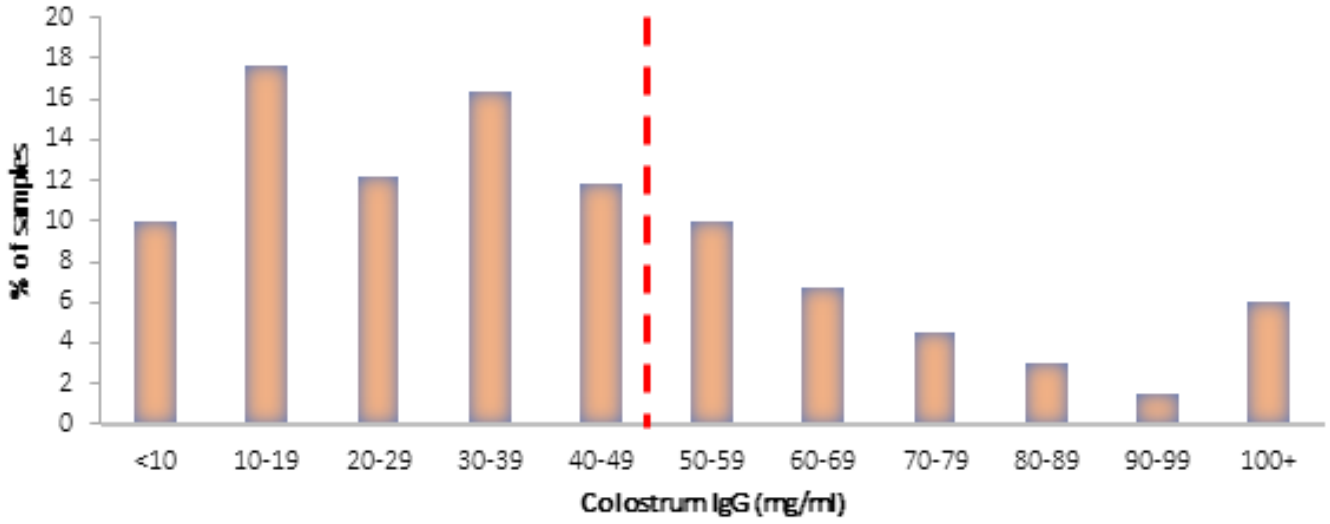

Figure 1. Colostrum quality assessed on NI farms where good quality is 50mg/ml IgG and above

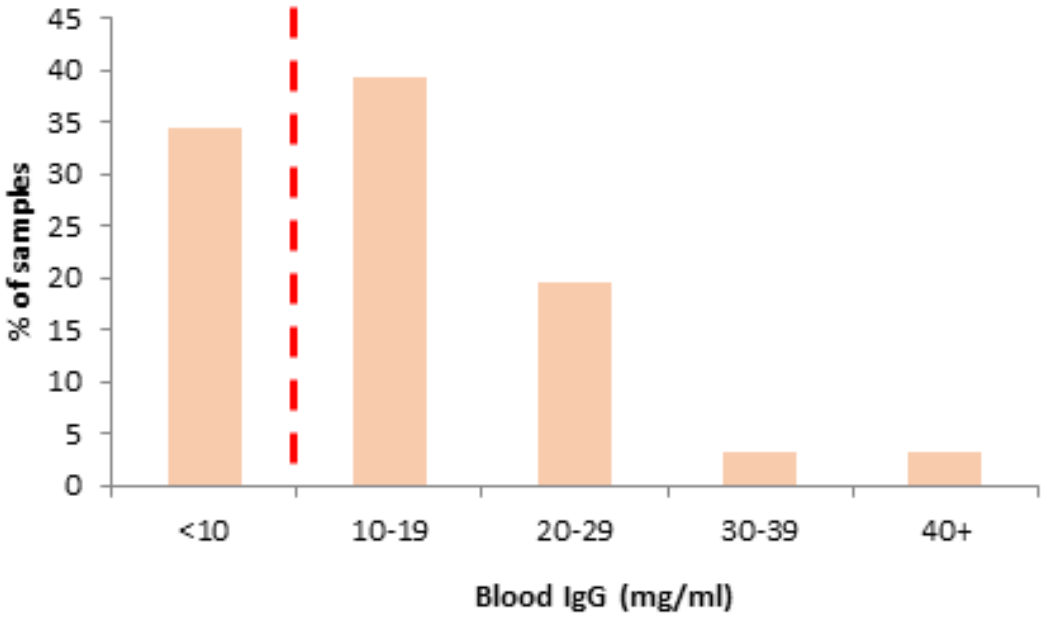

Figure 2. Blood IgG results from NI dairy farms, where failure of passive transfer is considered as a sample with <10mg/ml IgG

Blood samples were also taken from a total of 340 calves within 7 days of birth and serum was analysed to determine if passive transfer of immunity form the dam had occurred.

Health and mortality data was collected for a further 12 months to examine the impact of colostrum quality on incidence of ill health.

Research Findings

Approximately 67% of colostrum samples were assessed as being of low quality (Figure 1; <50mg/ml IgG) and calves provided with this low-quality colostrum were twice as likely to suffer from FPT as those provided with higher quality colostrum. Analysis of calf serum samples showed that 33.6% of calves had IgG levels indicative of FPT (Figure 2; <10mg/ml). When health records were examined, 33% of calves with FPT were treated for incidence of ill health in comparison to 25% of calves which had serum IgG levels indicative of successful passive transfer of immunity (>10mg/ml). Based on veterinary treatments, there was an 11% increase in pneumonia in FPT calves when compared to those which had received higher quality colostrum transfer (19% vs 8%, respectively). In terms of mortality, 6.4% of calves with FPT died whereas only 2.4% of calves with successful passive immunity were recorded dead.

Potential Impact for future farming

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, improved colostrum management has a positive impact for the health and performance of the future herd.

This study was funded by DAERA and AgriSearch.

Dairy Heifer Rearing

Gillian Scoley, AFBI & Jessica Cooke, Volac Milk Replacers Ltd

Resource use efficiency in dairy youngstock - Protein sources in calf milk replacers

Key Messages

- Demand for dairy protein within the human food industry is increasing
- Milk replacers containing a combination of vegetable and dairy protein or all dairy protein produced similar live weight performance
- Diet digestibility and nitrogen utilisation were comparable in calves offered milk replacer containing either all dairy protein or a combination of dairy protein and vegetable protein
- High-quality novel vegetable protein sources in combination with good quality dairy protein in calf milk replacer could represent an opportunity to help maximise dairy protein use efficiency

Background

A future challenge for agriculture in the UK and Ireland is the supply of dairy protein for pre-weaned calf diets due to the increasing demand from the human food industry. A primary focus of animal nutrition, in response to this challenge, lies in the identification of novel protein ingredients in calf diets. However, one of the barriers to progress in this area for calf nutrition, is the lack of understanding of different vegetable protein sources on digestibility and utilisation in the calf.

Commercially available milk replacers (MR) contain low levels of vegetable protein in combination with milk protein (skim and whey). The main source of vegetable protein is hydrolysed wheat gluten (HWG) due to its digestibility value and physical quality - however the availability of good quality HWG is limited due to an increased demand within the human food industry. Few studies have assessed the suitability of other vegetable proteins in MR and the impact on digestibility and early calf growth and development.

Figure 1. Liveweight of calves offered milk replacers with differing protein sources over the pre- and immediately post wean period

In a study funded by Volac Milk Replacers Ltd. and CIEL, AFBI investigated the suitability of alternative vegetable protein sources in calf MR.

Research Studies

Sixty-four dairy origin calves were housed as pairs and allocated to 1 of 4 MR treatments at birth:

T1: Control – All dairy protein (whey protein)

T2: Whey protein plus HWG

T3: Whey protein plus Vegetable Protein 1 (VP1)

T4: Whey protein plus Vegetable Protein 2 (VP2)

Intake of MR was recorded until weaning at day 56 and concentrate intake was recorded between day 5 and day 70. Live weight and withers height were measured every week between birth and day 70 and health was monitored throughout. A further 10 bull calves were allocated to each of the 4 treatments and underwent nitrogen utilisation and digestibility measurements at 3 timepoints (2-3, 6-7 and 9-10 weeks of age) in addition to the standard recordings described above.

Research Findings

Source of MR protein did not impact liveweight throughout the duration of the study (Figure 1), with daily live weight gain ranging between 0.71 and 0.77 kg/day between day 7 and day 70. There were no differences in total concentrate intake between treatments, nor in performance efficiency (kg gain/kg DMI) between birth and weaning.

Episodes of ill-health were not strongly linked to any of the dietary treatments and there were no differences in faecal scores throughout the study. Diet digestibility was similar across all treatments for each period of recording. Nitrogen utilisation efficiency was increased in T1 calves compared to T4 calves during the first measurement period (2-3 weeks of age), however, this did not occur in periods 2 or 3, where utilisation was similar across treatments.

Potential Impact for future farming

This study highlights that high-quality vegetable protein sources in combination with good quality dairy protein (whey protein) can be used in calf milk replacers without detriment to performance or diet digestibility. Identification of novel alternative protein sources for pre-wean calf diets will help maximise resource use efficiency of dairy protein and improve sustainability of dairy production through reducing competition with human edible products.

This project was funded by Volac Milk Replacers Ltd and UK Agri-Tech Centre.

Dairy Heifer Rearing

Gillian Scoley

HoloRuminant: Can early life management and nutrition have a lasting influence on long term performance, health, and overall resilience of the dairy herd?

Key Messages

- Management of calving in terms of removing calves at birth or allowing them to remain with the dam for the first 24 hours did not impact growth in the first 10 weeks of life
- Providing an increased level of milk replacer improved calf growth in the pre-and immediately post-wean period
- HoloRuminant will identify if the microbiome can be manipulated by early life management practices to improve long-term production efficiency and sustainability measures

Background

HoloRuminant is a Horizon2020 EU funded project involving 25 partner organisations spanning 17 different countries. The project aims to help develop our understanding of the role of the ruminant microbiomes and how it interacts with the animal itself. The microbiome is defined as 'a collection of microorganisms, including bacteria, viruses, fungi and their genes that are found naturally on different sites of the body, and which can have a significant impact on animal health and performance'. As part of the HoloRuminant Project, AFBI, working closely with QUB, is engaged in discovering how management around birth, the birth environment, milk replacer feeding level, and management in early life, impacts the establishment and persistence of the microbiome at several important body sites.

Research Studies

The study commenced in January 2022, with a total of 48 spring born Holstein heifer managed using several different approaches:

Management at calving: half of the calves remained with the dam for approximately 24 h after birth, while the other half were removed from the dam immediately following birth.

Level of milk replacer feeding: Calves were offered milk replacer at either a Conventional level (maintained at 4 litres/day) or Intensive level (built up to a maximum of 8 litres/day).

Management post weaning: Conventional calves were grazed between late June and early October and offered 1kg concentrate/head/day, whereas Intensive calves remained housed and were offered 3kg concentrate/head/day alongside ad lib grass silage. Similar differences in management have continued to be adopted during the second year of life. Cows will remain on the study for 100 days post calving.

Various samples have been collected throughout the calves' life, including from blood, rumen and skin samples. These will be analysed to determine how the microbiome establishes in early life and if it is persistent throughout the growing period and into the first lactation. This will also help to identify how management practices modulate the establishment and persistence of the microbiome.

Research Findings

Results to date indicate that either leaving the calf with the cow for 24 hours after birth, or removing immediately at birth had no effect on calf growth rate (Figure 1), however, as expected calves on the high level of milk replacer were heavier than conventional calves during the first 10 weeks of life (Figure 2).

Potential Impact for future farming

Results from the overall HoloRuminant project will help to identify how the microbiome of important body sites is established, modulated and maintained and subsequently influence the hosts growth, performance, efficiency and resistance to disease. Management and feeding practices linked to microbiomes which improve performance efficiency and health, and therefore reduced carbon footprint, can then be identified and adopted by producers to facilitate a more sustainable dairy production system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 101000213.

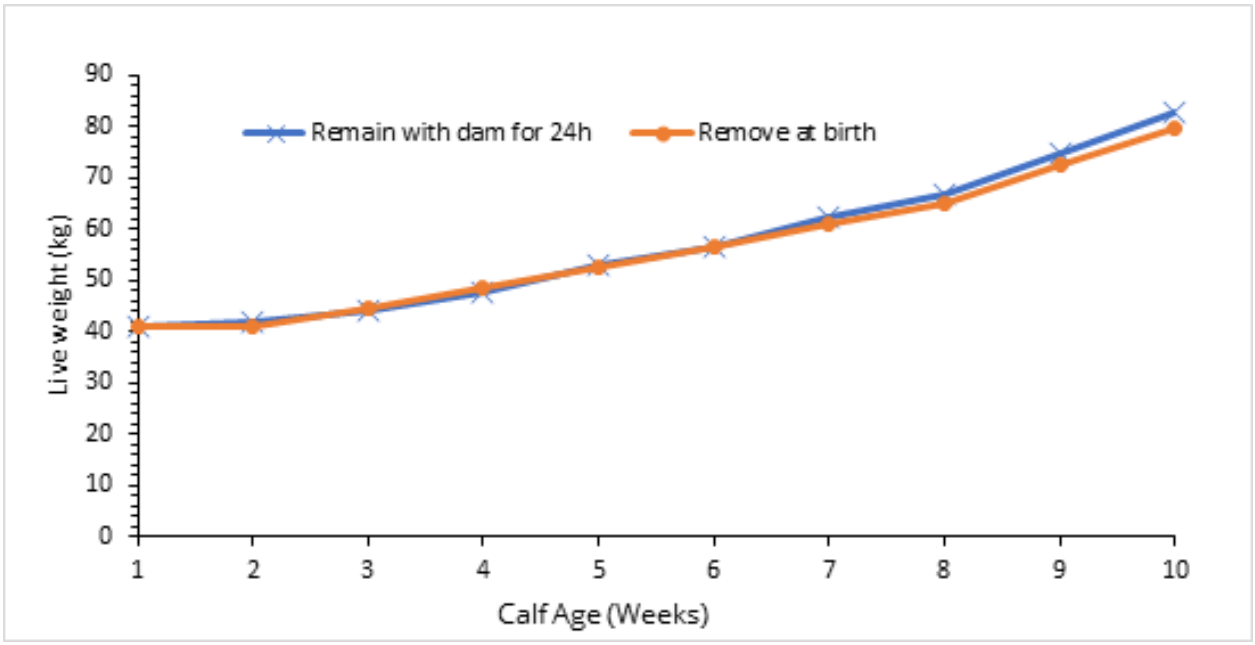

Figure 1. Liveweight of Remain and Remove calves during the first 10 weeks of life.

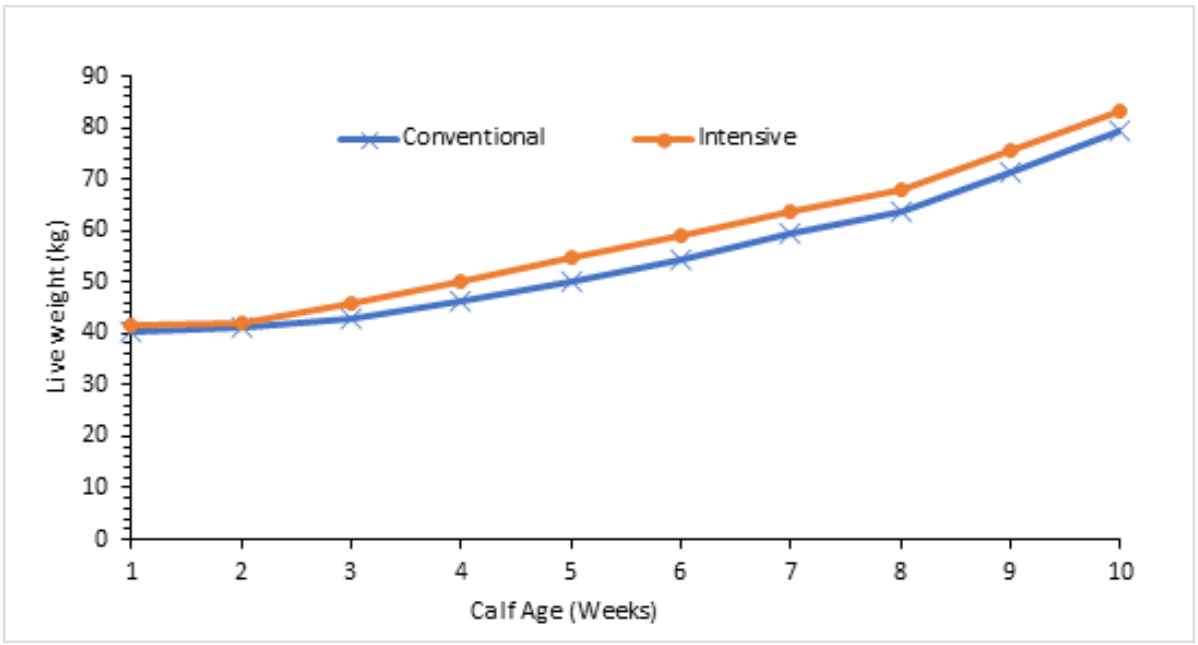

Figure 2. Liveweight of Conventional and Intensive milk fed calves during the first 10 weeks of life.

Multi-cut silage systems

Aimee Craig and Conrad Ferris

Improving forage quality in multi-cut systems

Increasing harvesting frequency is a practical way to improve silage quality and cow performance.

Key messages

- Harvesting grass more frequently for silage improves silage nutritive value but reduces herbage yield per ha.
- More frequent harvesting improved silage intakes and milk solid yields.
- Margin over-feed costs were increased with the 4-harvest system, but reduced with the 5-harest system due to the lower herbage yield.

Background

Given that silage digestibility (D-value) declines by an average of 3.3% for each one-week delay in harvest date, harvesting herbage earlier or more frequently can improve silage nutritive value. However, few studies have examined the impact of multi-harvest systems on dairy cow performance. Two studies were undertaken to investigate the impact of multi-harvest systems (4-Harvest or 5-Harvest) compared to a traditional 3-harvest system.

Research studies

Study 1 involved 80 dairy cows and compared a 3- vs a 4-harvest system over a 25-week period. Concentrates were offered on a feed-to-yield basis (average 13.4 kg/cow/day).

Study 2 involved 34 dairy cows and compared a 3- vs a 5-harvest system over a 21-week period. Concentrates were offered on a flat-rate basis (average 9.5 kg/cow/day).

Research findings

Increasing harvest frequency reduced herbage dry matter (DM) yield (from 13.4 to 12.3 t/ha in Study 1, and from 12.6 to 11.2 t/ha in Study 2), while increasing silage metabolisable energy content (from 10.7 to 11.3 MJ/kg DM in Study 1 and from 10.9 to 11.5 MJ/kg DM in Study 2).

Improved silage quality with the multi-cut systems increased silage DM intake, milk yield and milk fat + protein yield (Table 1).

Table 1. Performance of dairy cows offered silages produced within either a multi-harvest system (4- or 5-Harvest) or a 3-harvest system.

	HARVEST FREQUENCY		% DIFFERENCE COMPARED TO 3-HARVEST
Study 1	3-harvest	4-harvest	
Silage DM intake (kg/d)	9.5	10.4	+10%
Milk yield (kg/d)	37.3	39.7	+6%
Fat + protein yield (kg/d)	2.75	2.94	+7%
Margin-over-feed costs (£ per cow per day)	£6.65	£7.16	
Study 2	3-harvest	5-harvest	
Silage DM intake (kg/d)	11.7	14.1	+21%
Milk yield (kg/d)	31.9	33.5	+5%
Fat + protein yield (kg/d)	2.59	2.74	+6%
Margin-over-feed costs (£ per cow per day)	£8.08	£7.85	

Concentrate cost, £320 per t DM; milk price, 32 ppl; 3, 4 and 5 harvest silage, £150, £174 and £199 per/t DM, respectively

Margin-over-feed cost was calculated for the two studies using standard prices (Table 1). In Study 1 cows offered silage produced within the 4-harvest system had a higher margin-over-feed cost, while cows offered silage produced within the 5-harvest system in Study 2 had a lower margin-over-feed costs, despite their improved performance. The latter was due to the lower herbage yields increasing silage costs. As the herbage yields for the latter study are based on a single year, margin-over-feed costs should be treated with a degree of caution.

Potential Impact for Farming for the Future

This research has provided clear scientific evidence of improved silage nutritional value and cow performance from multi-harvest silages. Offering a more digestible silage provides an opportunity to produce a given milk output using a lower concentrate input.

Reducing the amount of concentrate feed offered to dairy cows will have a positive impact on the carbon footprint of milk production. Reducing concentrate feed will also reduce the amount of phosphorus brought onto the farm which will help reduce phosphorus balance. The economic impact of multi-harvest systems will be largely dictated by silage production cost, and the effects on feed intake versus the value of any additional milk produced. Strategies to maintain herbage yields within multi-harvest systems need to be identified.

Studies were Co-funded by DAERA and AgriSearch.

Autumn management of silage swards

Aimee Craig and Conrad Ferris

To graze or not to graze autumn growth – this is the question!

Differences between the 'grazed' and 'un-grazed' swards during February

Key messages

- Grazing autumn growth herbage with sheep improved quality of first cut silage, but reduced herbage yield.
- When offered silage produced from swards grazed in autumn, there were some improvements in cow performance; however, fat plus protein yield per ha was reduced.

Background

Milder winters, together with the practice of applying slurry to swards after the final harvest of silage, promote grass growth over the autumn and winter periods. However, if swards accumulate high herbage covers over the winter, some of this material can die within the sward and reduce the quality of first cut silage the following year. This study, co-funded by DAERA and AgriSearch, examined the impact on silage quality and subsequent cow performance of using sheep to remove this autumn grass.

Research studies

This study was repeated over two years. Following the harvest of third-cut silage in mid-September, a block of land was treated with slurry and half of it left ungrazed while the other half was grazed by a flock of sheep during December. Sheep were removed when a target cover of 1,400 kg DM/ha was obtained (post-grazing height of ~4 cm). Both swards ('Grazed' and 'Ungrazed') received slurry and fertiliser in the spring in preparation for first-cut silage. The two swards were harvested and ensiled in separate silos in early May, and the resulting silages offered to mid/late-lactation dairy cows.

Table 1. The performance of cows offered silages produced from swards that where either grazed by sheep or left ungrazed during the autumn/winter period (significant differences indicated by the % change).

	YEAR 1		% CHANGE	YEAR 2		% CHANGE
	UNGRAZED SWARDS	GRAZED SWARDS		UNGRAZED SWARDS	GRAZED SWARDS	
Silage DM intake (kg/day)	16.3	16.8		11.6	13.3	+14%
Milk yield (kg/d)	26.2	27.0	+3%	20.8	21.4	
Fat content (%)	5.08	4.98		5.21	5.71	+10%
Protein content (%)	3.72	3.71		3.88	3.87	
Fat plus protein yield (kg/day)	2.31	2.34		1.90	2.07	+9%
Fat plus protein yield (kg/ha)	735	699		1086	920	

Research findings

Grazing the swards during December reduced dry matter (DM) yield at harvest the following spring (0.8 and 1.0 t DM/ha greater with the Ungrazed swards compared to the Grazed swards in Years 1 and 2, respectively). The chemical composition of silages made from Grazed and Ungrazed swards were similar, with the exception of metabolisable energy (ME) content (0.2 and 0.5 MJ/kg DM higher with the Grazed swards compared to the Ungrazed swards in Years 1 and 2, respectively).

In Year 1, silage DM intake was unaffected by treatment, but cows offered silage made from the Grazed sward produced more milk (Table 1). In Year 2, cows offered silage produced from the Grazed sward had a greater silage DM intake, resulting in an increase in fat plus protein yield, compared to cows offered silage from the Ungrazed sward. Accounting for herbage DM yields and cow performance, fat plus protein yield per ha was reduced with the Grazed swards.

Potential Impact for Farming for the Future

Using sheep to remove grass that grows during the autumn period can improve silage ME content and result in small improvements in cow performance. However, due to lower herbage DM yields when swards are grazed during autumn, fat plus protein yield per ha may be reduced. As milder winters become more common the growing season will be extended, and this will likely result in heavier grass covers on the silage platform over the winter. Should this situation arise then the benefits of grazing these heavier swards during the winter may be increased.

This project was Co-funded by DAERA and AgriSearch.

Dairy cow feeding

Aimee Craig and Conrad Ferris

Precision feeding in feed-to-yield dairy systems

Key Messages

- Increasing precision in concentrate feeding by adjusting for individual cow milk composition and intakes did not improve efficiency, ie milk yield per kg of DM intake.
- To improve efficiency of feed-to-yield systems producers should focus on monitoring forage quality, concentrate feed rates and accuracy of feeding equipment.

Background

Many dairy farmers have adopted a feed-to-yield approach to concentrate feeding. In practice, a forage or forage-concentrate mix (basal ration) is offered, and this is assumed to meet the cow's maintenance requirements plus a given amount of milk. Additional concentrates are then offered to individual cows on a feed-to-yield basis to support milk produced in excess of the yield that the basal ration supports. Many of the assumptions used are based on an 'average cow' and this may lead to overfeeding or underfeeding of individual cows.

This study, which was co-funded by DAERA and AgriSearch, was designed to examine feed-to-yield strategies to increase the precision of concentrate allocation.

Research study

For 12 weeks 69 mid-lactation Holstein dairy cows were offered the same basal ration. Individual cows were offered additional concentrates on a feed-to-yield basis according to one of three approaches, as follows:

1. **Conventional:** The milk yield supported by the basal ration (M+) was determined based on the average group intake. Individual cows were then supplemented with concentrates at a rate of 0.43 kg concentrate per kg milk produced in excess of the M+ value.
2. **Precision 1:** the approach was similar to the 'conventional' treatment above, except in this treatment the concentrate feed level for each cow was adjusted accounting for individual cow milk yield and milk composition.
3. **Precision 2:** similar to Precision 1, however this treatment also accounted for differences in intakes between individual cows.

Research findings

The results are presented in Table 1 (next page), and values with a circle around them were statistically different from the values in the Conventional treatment. Cows managed using the two precision approaches consumed more concentrates per day, compared with cows on the Conventional treatment. As a result, silage intake tended to be lower with Precision 1 and 2.

There was no effect of treatment on milk yield or milk fat content; however, milk protein content was higher with the Precision 1 and 2, reflecting the higher concentrate levels offered in these treatments. Cows on Precision 1 had the highest yield of fat plus protein (+0.13 kg/day). However, efficiency was not improved with the precision feeding approaches. For example, the amount of milk produced per kg of dry matter intake was almost identical across the three treatments. Furthermore, more concentrate was offered per kg of milk (+0.04 kg) within the Precision treatments compared to the Conventional treatment.

Potential Impact for Farming for the Future

A successful precision concentrate feeding strategy was expected to reduce concentrate inputs while maintaining or improving cow performance. However, this was not the case in the current study. Instead producers should bring as much precision into their conventional feed-to-yield systems as possible by having good estimates of herd intakes, monitoring of forage quality, checking the feed-rate setting and ensuring that weigh cells in concentrate feeding systems are calibrated and accurate to improve concentrate use efficiency.

This project was Co-funded by DAERA and AgriSearch

Table 1. Effect of three different feed-to-yield strategies on intakes, milk production and efficiency measures (values with circles where statistically 'significantly' greater than those for the Conventional treatment)

	TREATMENT		
	CONVENTIONAL FEED-TO-YIELD:	PRECISION 1: (CONCENTRATE LEVEL ADJUSTED FOR MILK YIELD AND COMPOSITION)	PRECISION 2: (CONCENTRATE LEVEL ADJUSTED FOR MILK YIELD, MILK COMPOSITION AND INTAKES)
Silage dry matter intake (kg/d)	12.4	11.6	11.5
Concentrate dry matter intake (kg/d)	9.4	10.5	10.3
Milk yield (kg/d)	32.9	34.5	34.3
Fat (%)	4.51	4.49	4.31
Protein (%)	3.27	3.35	3.31
Fat plus protein yield (kg/d)	2.54	2.69	2.58
Kg milk produced per kg dry matter intake	1.63	1.65	1.64
Kg concentrate offered per kg milk	0.30	0.35	0.34

Feeding Dairy Cows

Aimee Craig, Xianjiang Chen and Conrad Ferris

Reducing crude protein levels in rapeseed-based diets

Key Messages

- Reducing total diet crude protein to 14% improved nitrogen-use-efficiency
- A total diet crude protein content of 14% reduced cow performance
- Reducing total diet crude protein reduced ammonia emissions from manure

Background

Reducing crude protein (CP) levels in dairy cow diets can improve the efficiency with which feed nitrogen is converted into milk nitrogen (nitrogen-use-efficiency), while reducing nitrogen loss to the environment as ammonia, nitrous oxide and nitrate. Ammonia is produced when faeces (which contains the enzyme urease) and urine (which contains urea) mix, with this process taking place on the floors of livestock houses, during slurry storage and at field spreading. The ammonia gas produced may be deposited locally on sensitive habitats, where the nitrogen within ammonia can cause nutrient enrichment of soil and water and lead to biodiversity loss. An early study which used soyabean meal as the primary protein source suggested a CP level of 15.5 – 16% is optimal to maintain production, provided metabolisable protein requirements are met, while also improving nitrogen-use-efficiency.

However, given societal concerns about unsustainable soya-bean production practices, the current study examined the impact of offering soya-free diets on cow performance and ammonia emissions.

Research study

This full lactation study involved 88 dairy cows and examined three soya-free diets containing either 14%, 15.5% or 17% CP (on a dry matter (DM) basis). The diets also differed in metabolisable protein content, with 14% CP diet being deficient, 15.5% CP diet being marginally deficient and the 17% CP diet oversupplying metabolisable protein (MP-N). The main protein source used was rapeseed meal. Samples of faeces and urine were collected, and after mixing, the manure was incubated for a four-week period to examine ammonia emissions.

Research findings

Dry matter intake, milk yield and fat plus protein yield increased as total diet CP (and metabolizable protein supply) increased (Table 1). The 14% CP diet improved nitrogen-use-efficiency compared with the other treatments.

Ammonia production was highest during the days after the faeces and urine were mixed, and gradually decreased over time. Reducing CP levels from 17% to 14% reduced ammonia emissions by an average of 64%, with emissions from the 15.5% CP diet intermediate (Figure 1).

Table 1. Performance of cows offered rapeseed-based diets differing in crude protein level.

	TREATMENT DIET			SIGNIFICANT
	14% CP	15.5% CP	17% CP	
Total DM intake (kg/day)	21.2	22.0	22.9	Yes
Milk yield (kg/day)	31.5	32.7	34.8	Yes
Fat + protein yield (kg/day)	2.64	2.75	2.94	Yes
Nitrogen-use-efficiency (%)	36	34	34	Yes

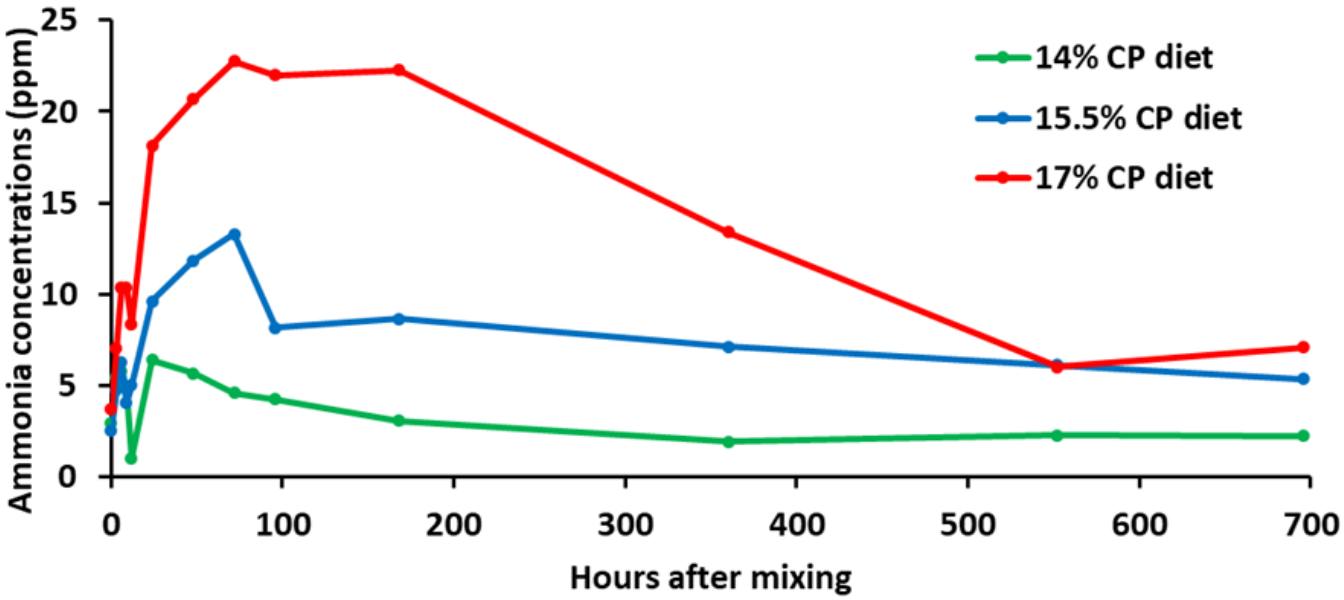

Figure 1. Changes in ammonia emissions from slurry produced by dairy cows offered diets containing 14%, 15.5% and 17% crude protein (CP)

Potential Impact for Farming for the Future

These results demonstrate that cows can perform well on rapeseed-meal based diets, although performance was reduced when metabolisable protein requirements were not met. With careful ration formulation, soya-free diets could be offered in Northern Ireland.

Reducing diet CP levels reduced ammonia emissions and improved nitrogen-use-efficiency, but the environmental gains should be considered alongside the reduction in cow performance when the 14% CP diet was offered.

This study was co-funded by DAERA, John Thompsons and Sons Ltd and Trouw Nutrition Ltd.

Dairy Cow Nutrition

Aidan Cushnahan and Conrad Ferris

Reducing the use of human-edible feedstuffs in dairy cow diets

Key messages

- Feeding concentrates with a low human-edible fraction to dairy cows offered a grass silage-based diet increased feed intake but did not affect fat plus protein yield
- Reducing levels of cereals and soya bean in a concentrate and replacing them with by-product ingredients led to an increase in edible feed conversion rate of cows offered this feed

Background

Dairy cows convert feeds that are inedible to humans (for example grass) into milk, a highly nutritious foodstuff. However developments in dairy genetics have resulted in management systems which rely more on concentrate supplements to support milk production. These concentrates often contain ingredients, such as wheat, maize and soya bean, which could be consumed by humans, otherwise known as human-edible ingredients.

Making greater use of ingredients with a low human-edible fraction such as rapeseed, distillers grains and sugar beet pulp could enhance the long term sustainability of milk production systems. These ingredients also have a lower carbon footprint compared to soya and cereals. However little information is available on how adopting this strategy of making greater use of low human edible feedstuffs would impact the performance of dairy cows under local conditions. The DAERA funded SusMilk project is addressing this knowledge gap by examining the effects on dairy cow performance of reducing the inclusion of “human-edible” ingredients (cereals and soya bean) in concentrates and replacing them with “low human-edible” by-product based ingredients.

Research studies

An initial study examined the effect of reducing human edible ingredients in the diet of mid lactation cows offered a grass silage-based diet. Concentrates were offered within a total mixed ration that contained either 54 % human-edible ingredients (high in human-edible ingredients) or 18 % human-edible ingredients (low in human-edible ingredients). Daily dry matter intake (DMI), milk yields, milk composition, feed conversion rate (FCR = kg milk per kg DMI) and edible feed conversion rate (eFCR = MJ human-edible output per MJ human-edible input) was monitored.

Table 1. Effect on dairy cow performance of reducing the inclusion of human-edible feed ingredients in rations

	RATION LOW IN HUMAN-EDIBLE INGREDIENTS	RATION HIGH IN HUMAN-EDIBLE INGREDIENTS
Human-edible fraction (%)	18	54
Total intake (kg DM per cow per day)	20.6	19.9
Milk yield (kg per cow per day)	30.1	29.3
Milk fat (%)	4.61	4.82
Milk protein (%)	3.48	3.63
Fat + protein yield (kg per cow per day)	2.43	2.47
Feed Conversion Rate (FCR)	1.48	1.47
Edible Feed Conversion Rate (eFCR)	3.86	1.44

Research findings

Cows offered the concentrate low in human-edible ingredients had higher intakes and milk yields than cows offered the concentrate high in human-edible ingredients, while milk fat and protein concentration were reduced. Concentrate type had no effect on the yield of fat plus protein. Reducing the human-edible fraction of the concentrate had no impact on FCR but eFCR was considerably improved. Further trials are being carried out to assess the long-term effects of feeding these rations to dairy cows.

Potential Impact for Farming for the Future

Reducing the human-edible fraction in dairy cow concentrates allows us to exploit the potential of by-product ingredients while releasing cereals and soya bean meal to feed the world's growing population. Further studies are required to assess the full impact of adopting this approach.

This project was funded by DAERA.

Dairy cow performance and milk composition

Anna Lavery and Conrad Ferris

Using milk composition data to manage nutrition- milk fat: protein ratio and milk urea content

Key Messages

- Mid-infrared spectroscopy (MIR) analysis can be used to predict milk composition.
- Milk fat-to-protein ratio can help identify cows that may be 'metabolically at risk' but cannot be used to determine the energy balance of individual cows.
- The potential of both milk urea and MIR spectra to predict nitrogen-use-efficiency is being examined.

Background

Milk analysis, a non-invasive tool, can tell us much about the cow that is producing the milk. Most milk samples collected by milk processors and milk recording organisations are analysed using MIR. In addition to providing information on milk fat, protein and urea, the 'spectra' produced by MIR (each 'spectra' comprises >1000 data points) can be used to obtain more information about individual cows.

Research studies

Recent and current projects include:

The 'Nutrigen' project examined if the fat-to-protein ratio of milk could be used to accurately predict the energy balance of individual cows.

The 'GplusE' project (EU funded) examined if MIR could be used to predict nitrogen-use-efficiency (NUE) and methane emissions from individual cows.

AFBI is currently assessing if milk urea can be used to predict the nitrogen-use-efficiency of a herd.

A MIR instrument which is used to predict milk composition.

Research findings

While fat-to-protein ratio is used by nutritionists as an early indicator of nutritional problems within a herd, we examined if this ratio could be used to predict the energy balance of individual cows. As energy balance becomes more negative (i.e. cows mobilise more body tissue), the fat-to-protein ratio of milk increases (Figure 1). Cows with a fat-to-protein ratio greater than 1.5 (dots in the red circle) almost all have a negative energy balance, so we can be reasonably confident that these cows are metabolically challenged.

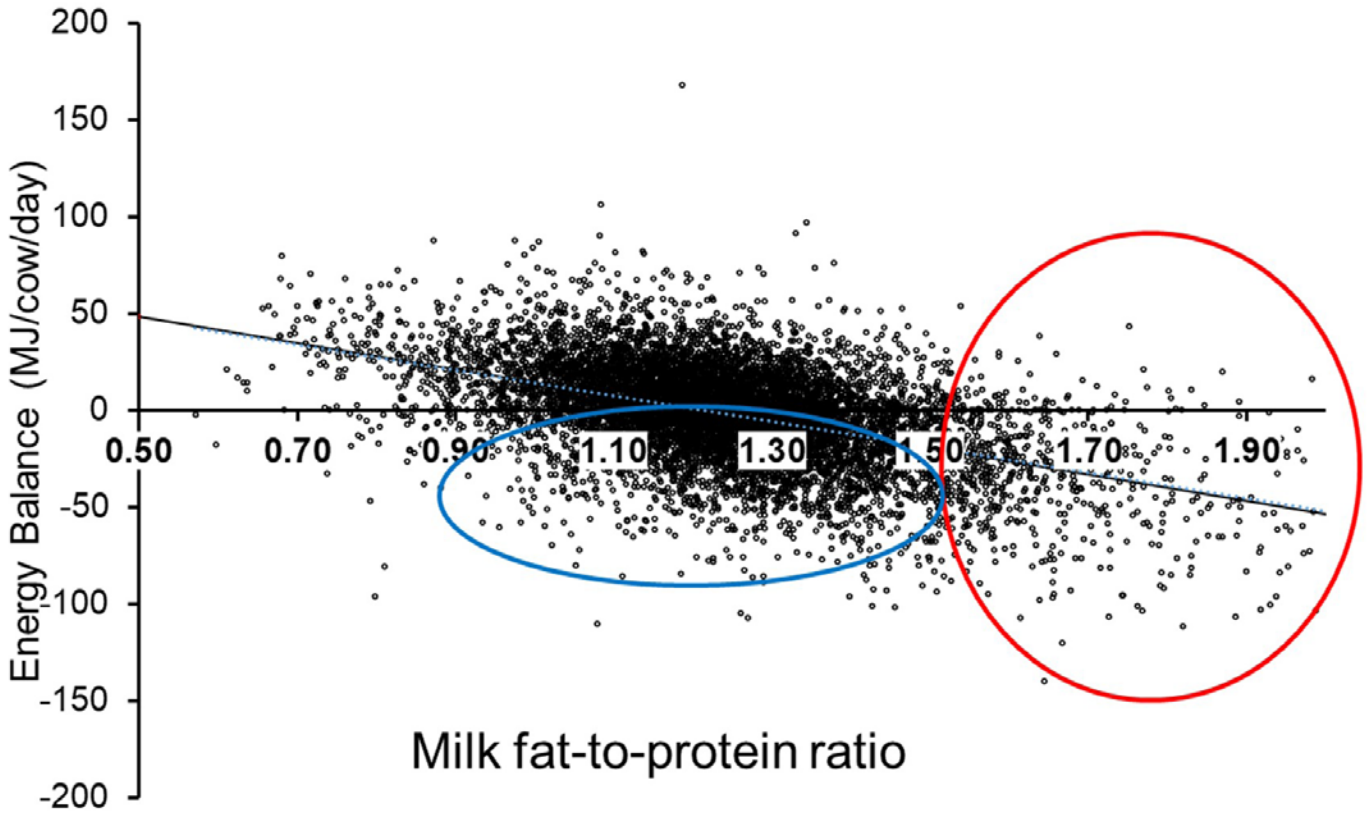

Figure 1. Relationship between energy balance and milk fat-to-protein (1st lactation cows).

However, Figure 1 also shows that cows with a fat-to-protein ratio between 1 - 1.5 were also in negative energy balance (dots in the blue circle). From this analysis, milk fat-to-protein ratio alone cannot be used to accurately predict the energy balance of individual cows. Instead, fat-to-protein ratio can be an early indicator of an imbalance in nutrition, when considered within the context of other diet and herd factors.

Excess dietary nitrogen is excreted primarily as urea in urine and has a detrimental effect on the environment. Our research is currently examining if we can use milk urea to predict how much nitrogen individual cows are wasting (i.e. their NUE). While there are relationships between NUE and milk urea, it is unclear if this can be used as a predictive tool. AFBI are examining if the MIR spectra can be used to predict NUE. Early results suggest this is possible, however we are now reexamining this using a larger dataset for grass silage-based diets.

Potential Impact for Farming for the Future

Milk analysis when examined with diet and herd factors can potentially help farmers to better manage the nutrition of their herd and improve efficiency, reducing the environmental impact of dairy farming i.e. improving nitrogen-use-efficiency, reducing nitrogen excreted and lowering ammonia emissions.

The Nutrigen project was funded by DAFM, carried out in partnership with DAERA, AFBI, UCD and Teagasc. The GplusE project was funded by the European Union, involving 15 research and industry partners across Europe. The current project is funded by DAERA, in partnership with John Thompsons and Sons Ltd and Trouw Nutrition.

Feed into beef nutrition (FIBNUT)

Francis Lively, Tianhai Yan, Denise Lowe, Edward Garcia, Xianjiang Chen, Richard Dewhurst, Gemma Millar and Jenna Boden.

Revising the nutritional guidelines for beef cattle

Key Messages

- Knowing the forage quality is critical to accurately predict the dry matter intake of the animal to be able to formulate a ration.
- The Feed into Beef Nutrition (FIBNUT) project has revised the energy requirements for maintenance for modern cattle. This revision has found that maintenance requirements are approximately 20% higher than those reported in AFRC (1993).
- Genetic improvements in cattle have led to changes in body composition which needs to be taken into account when formulating rations for beef cattle.

Background

There was strong evidence that the nutritional guidance for rationing beef cattle in the UK (AFRC, 1993) was inaccurate and outdated. This could reflect changes in the feeds, management systems and the genetic base of the UK cattle population since the guidelines were published.

The FIBNUT consortium (AFBI, SRUC, CIEL and industry advisory group) was established to update the nutritional guidelines based on more recent scientific data using typical beef production systems currently adopted within the UK, through AHDB funding.

Table 1. Metabolisable energy requirement (MJ/day) of steers using new FIBNUT equations (assuming a diet of 11.3 MJ/kg DM (ME/GE = 0.6))

BREED TYPE	LIVE WEIGHT (KG)	0.5 KG/DAY	1.0 KG/DAY	1.5 KG/DAY
Early maturing	**200**	44.9	59.9	77.8
	400	73.6	96.7	124.2
	600	98.8	128.9	164.8
Medium maturing	**200**	44.0	58.0	74.6
	400	72.2	93.7	119.3
	600	97.0	125.0	158.4
Late maturing	**200**	43.1	56.0	71.4
	400	70.9	90.8	114.4
	600	95.2	121.1	152.0

Research studies

The project utilised available data within AFBI and SRUC to validate a range of internationally available prediction models for rationing beef cattle to test their suitability and accuracy for UK conditions. Where new data was available, new prediction equations were developed. Where new data was not available, engagement with industry lead to modifications of existing models. Collectively, a range of new nutritional guidelines were developed and evaluated by an industry advisory group.

Research findings

Predictions for dry matter intake of beef cattle are improved when animal live weight, concentrate proportion offered, quality of the grass silage offered and overall quality of the diet are supplied. Knowing the quality of the forage significantly improves the accurately of the predictions.

A key finding was that the energy requirements for maintenance has increased by ~ 20% relative to the AFRC (1993) guidelines. Limited new information was available for protein requirement, however with an increased dry matter intake and energy intake, protein intakes are higher than previous estimates which needs further investigation to minimize losses to the environment.

Since, AFRC (1993) was undertaken the composition of gain has changed, with British breeds now being much larger and more similar to continental breeds. Therefore, adjustment factors taking account of animal classification have been adjusted to reflect these changes.

Potential Impact for Farming for the Future

Improved nutritional guidelines will enable nutritionists to formulate diets more accurately in the future. This will enable farmers to more accurately match the animals nutritional requirements with feed supply and therefore will ensure animals perform as expected. This will result in farmers being able to meet their target performance levels in a more cost effective manner.

This project was funded by AHDB.