European Innovation Partnership (EIP) Wales

Improving suckler herd management through nutrition and hygiene around calving time to enhance productivity and reduce antibiotic use

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Executive summary

Health issues cost the UK beef industry an estimated £133m in lost productivity and mortality. A significant proportion of these losses occur early in the life of the animal. At the same time, there is an urgent need reduce antibiotic use to slow down the development Antimicrobial Resistance (AMR) and prolong the useful life of treatments for medical and agricultural use. Good management around calving is central to ensuring good health and productivity of the herd, reducing the reliance of antibiotic use, and securing the viability of the farm business.

The project aimed to:

- Develop and inform good practice including: optimising cow nutrition; improving hygiene at calving; increasing colostrum quantity/quality; and addressing underlying disease issues
- Reduce the use and costs associated with antibiotics and treatment of ill livestock by developing a proactive approach to disease prevention and avoiding prophylactic use of antibiotics
- Reduce calf and cow losses and presence of ill health

Historical use of antibiotics was analysed on participating farms to highlight specific disease issues. A disease monitoring programme was put in place, using several approaches including metabolic profiling, faecal sampling and internal parasite monitoring

Good nutrition is essential to maintaining the health of both cows and calves. The absorption of colostrum and the quality of silage was monitored and based on these results pre and post calving diets were developed for the cows. Soil analysis was carried out with a view to address silage quality though good plant nutrition.

All the above information was brought together to draw up recommendations for the participating farmers and the industry more widely. These included:

- Monitoring for diseases is important to ensure appropriate protection and control measures are used, for example, many herds are now testing for BVD and some for Johnes. Other diseases, such as Blackleg and other clostridial infections are ubiquitous and could potentially occur in any herd at any time.
- Establish your herd status for diseases and developing a control plan with your vet to minimise losses. If purchasing cattle, check the status of the herd you are purchasing from.
- Ensure there is good biosecurity and biocontainment on the farm.
- KPIs are important to give a baseline to allow farmers to compare yearly performance on individual farms and against other farms. The KPIs used in this study give a good overall impression of the suckler herd performance.
- Hygiene during housing is vital to reduce the exposure of the newborn calf to infections when it does not have a developed immunity. Sheds should be mucked out every 3 weeks to reduce the level of infection. Lime and disinfectant can be applied at the time of fresh bedding application to help reduce moisture levels and infection load. It is important to place water troughs and drinkers in a well-drained place and ensure they are well maintained to reduce leakages onto bedding.

- The calving period is crucial to the rest of the farm's productivity and profitability. Optimising colostrum and milk when a calf is born has a positive impact on the calf through to weaning. In suckler herds there is often a reluctance to feed pre-calving due to risk of over-sized calves being born leading to calving difficulties and subsequent losses.
- Supporting nutrition in the last few weeks before calving will help increase the effective rumen degradable protein (ERDP) supply, resulting in less body condition loss and better colostrum quality and quantity, improving calf health and performance.
- Forage analysis is an important basis for developing pre and post calving diets .
- There is a direct relationship between soil nutrient status/ pH and the nutritional quality of silage. Good soil management is the foundation of good cow nutrition. It is important to test soil regularly and address nutrient deficiencies 'at source.'

Contents

1. Introduction

Health issues cost the UK beef industry an estimated £133m in lost productivity and mortality. A significant proportion of these losses occur early on in the life of the animal. Scouring in calves, alone, accounts for £11 Million of those losses. On average only 88% of calves are born alive (per 100 cows/heifers to bull) and of those 4% die between birth and weaning. Common causes include bovine viral diarrhoea (BVD), scouring, pneumonia, cryptosporidium, rotavirus, coccidiosis, and corona viruses (O'Shaughnessy et al., 2015).

At the same time, there is an urgent need to reduce antibiotic use to slow down the development Antimicrobial Resistance (AMR) and prolong the useful life of treatments for both human and animal use. While in general terms, antibiotic use is lower in beef compared to sheep they are widely used against some key problems including E-coli infections, pneumonia and coccidiosis. The most recent AHDB stocktake (2016) suggests that veterinary costs, on average, account for about 20% of the total costs to suckler herds in the UK. Meanwhile studies of comparable systems in Ireland indicate that a little over 20% of indivual calves are treated for diseases and the highest disease prevalence was in the first 30 days of life (Earley et al., 2019).

Management around calving therefore has a profound effect on the health and productivity of the herd and the viability of the farm business. Good management is also central to reducing reliance of antibiotic use, which is key for the Government and farm businesses alike. RUMA (Responsible Use of Medicines in Agriculture Alliance) have developed four rules for managing diseases with reduced reliance on antibiotics :

- Biosecurity
- Reducing stress
- Good hygiene
- Good nutrition

2. Aims

The project aimed to:

- Develop and inform good practice, in line with the RUMA rules, through management including: optimising cow nutrition; improving hygiene at calving; increasing colostrum quantity/quality; and identifying and addressing any underlying disease issues
- Reduce the use and costs associated with antibiotics and treatment of ill livestock by developing a proactive approach to disease prevention and avoiding prophylactic use of antibiotics
- Reduce calf and cow losses and presence of ill health

Data collected from participating farms was used to develop farm specific management plans which delivered to the aims of the project

3. Methodology

3.1 Participants

Participating farmers were highly experienced producers, managing herds of between 30 and 45 suckler cows. They were motivated to participate because they saw potential to reduce calf mortality and the prevalence of disease issues at this crucial stage and increase growth rates and productivity substantially. Lack of a structured monitoring programme was a key issue, and they saw the project as an opportunity to collect robust information as a basis for the development of management plans. Some also saw the project as part of their preparation for Brexit, where increased quality and productivity will become increasingly important for the viability of businesses.

Initially there were four farmers in the group. However, two withdrew, one because of ill health and the other because of changing priorities on the farm. Details of the farms and farming systems are provided in Section 4.1.

3.2 Timescale

The project timescale was from 1st November 2020 to 30th June 2022

3.3 Baseline data collection

Historical data was collected to be used to benchmark changes in health, productivity and antibiotic usage as a result of the project. Information included:

- Key performance indicators including:
    - Breeds of cows
    - Live calves born vs calves sold
    - Calf mortality
    - % calving (live calves/100 cows to bull)
    - Calves reared to weaning (%)
    - Calving index
    - Calving spread
    - Growth rates (Kg/ day)
- Animal health issues on the farm over the previous 3 years, including the number of calves treated for scour and pneumonia
- Veterinary treatments over the last 3 years
- Post-mortem results
- Other investigations, such as blood tests in previous 5 years
- Feed and forage analyses from the previous year
- Soil and mineral tests from the previous 10 years

3.4 Monitoring programme

On each farm, data was collected from the study groups at key times relative to calving, as detailed in Table 1.

	1 Mth before	Calving	1-3 Mths after	Collected by	Notes
Animal health monitoring					
Faecal sampling of calves		✓	✓	Farmers	Samples from sick calves as symptoms present
Bedding analysis		✓		Farmers	Taken on basis of metabolic profiling results
Fluke	✓	✓	✓	Vets	Taken on basis of metabolic profiling results
Post-mortem results		✓	✓	Vets	As deaths occur
Calving issues		✓		Farmers	Assisted, vet involvement and caesareans recorded
Antibiotic treatments	✓	✓	✓	Farmers	Number, type, dosage and date recorded
Annual medicine (mg/ PCU)	✓	✓	✓	Vets	
Nutrition					
Feed analysis	✓			Farmers	Standard & mineral analysis of silage and fresh grass
Metabolic profiling	✓		✓	Vets	Blood samples
Colostrum absorption		✓		Vets	Blood samples
Key performance indicators					
% calving		✓		Farmers	Number of heifers to bull that calve
Number calves born dead		✓		Farmers	
Calf deaths within 48 hrs of birth		✓		Farmers	
No. calves reared to weaning			✓	Farmers	
Number of calves sold			✓	Farmers	
Growth rates		✓	✓	Farmers	Monthly weight measurements of calves/ young stock
Calving spread		✓		Farmers	
Calving index		✓		Farmers	
Financial data	✓	✓	✓	Farmers	Using 'Measure to Manage' recording systems

Table 1: Monitoring programme

Metabolic profiling was an important tool in the monitoring process. It involves analysing blood samples to investigate various parameters to provide information on protein, energy and mineral status of the cows. It is widely used as a nutritional tool, giving an indication of both the short-term and longer-term nutritional status of the herd. However, it can also be an indicator of the presence of disease issues, for example:

- β - hydroxybutyrate (BHB) is indicative of ketosis. Elevated levels of BHB also increase susceptibility to infection, reduce milk yield, impair reproduction and increase the risk of culling.
- Proteins levels can be monitored by testing several factors. For example: low albumin will show potential protein loss due to worms/fluke/scour; and high globulins is a general indicator of a microbial infection.

Blood tests were taken one month before and one to three months after calving.

3.5 Antibiotic usage

Where available, antibiotic usage in the year prior to the project and during the project itself was monitored. The results were used to identify key areas where usage could be reduced and highlight how disease monitoring could play an important part in achieving this.

3.6 Nutrition

Silage samples were taken from each farm and the results used to draw up diets for pre and post calving to show how cow nutrition could be optimised in this critical period.

Colostrum absorption in calves was also measured.

3.7 Soil sampling

Soil nutrient status has a direct impact on silage quality. Soil samples were taken and analysed, including trace elements. The results were used to show how soil management/ amendments could reduce/ address any nutrient deficiencies in the silage.

3.8 Development and implementation of management plans

The data collected was used to develop the management plans, which included:

- Ration formulation, based on metabolic profiles and feed/ forage analysis
- Strategies to increase colostrum quality and absorption
- Strategies for preventative management of diseases, including cleaning and hygiene protocols, based on the results of bedding analysis, faecal sampling and post-mortem results
- Framework for decision making on antibiotic treatments

4. Results and discussion

4.1 Farm profiles

The basic characteristics and background of the farms are detailed in Table 2 below

Characteristic	Farm A	Farm B
Herd description	Aberdeen Angus	Pure Limousin suckler cows; Heifers are home replacements.
Calving pattern	Spring block from March	Calves are born and weaned early spring.
Calving system	Dry cows are housed in straw-bedded cubicles. 6 or 7 cows will be moved at a time into the calving pen. The calving pen is cleaned & disinfected before use. Lambing and calving happen at the same time. As lambing sheds are cleared, cows and calves move in. The cows and calves are turned out in May and bulling heifers turned out in April. Bucket reared calves are also bought in to rear, and some retained as bulling heifers for the suckler herd.	Turned out as soon as possible after calving in the spring. Less time indoors has reduced health issues they used to see when they calved earlier, and the cows and calves were housed longer after calving.
Feeding	First cross cows are only fed silage pre-calving. Cows are given a selenium, iodine, cobalt and copper bolus pre-service.	The cows are given a selenium and iodine bolus pre-calving and have access to 'Lifeline' buckets and very few issues are identified.
Housing	Sheds had reasonable ventilation but were on the dark side during January visit	The cows are housed in cubicles
Routine Vaccinations	• BVD • Leptospirosis	• Pneumonia (calves) • BVD (Cows routinely, young stock on the basis of blood tests • Leptospirosis (cows) • Rotavec-Corona (cows, pre-calving)

Characteristic	Farm A	Farm B
Health issues	• Cryptosporidiosis in calves in some years. Treated with Halocur. • Blackleg in 2021 - vaccination prior to turn-out. • TB Free for 10 years	• Previous Johnne's issues but has been testing for over 20 years and just get an odd positive case now.
Other comments / issues	In 2021 one breeding bull had low fertility resulting in too many barren cows. More bucket reared calves were bought in 2022 to compensate and more heifers were also retained The new bull lost a lot of condition through the service period, he was reported to have been diagnosed with a gut parasite problem and was then over fed to support him which may have given him acidosis. Future bulls will be fertility tested and health checked before use. Cattle vaccinated against BVD and Leptospirosis. In 2021 concentrate feed ran out close to turn-out and this corresponded with some high NEFA results in the cows.	The cows are generally in good body condition, but the aim is to ensure they don't get too fat, especially the autumn calving cows. Poorer silage is kept for cows and better quality for the youngstock. The majority calve in spring but due to bull issues a few years ago there are 8 to calve in the autumn .

Table 2: Key characteristics of participating farms

4.2 Disease monitoring

4.2.1 Metabolic profiling and bedding analyses

Metabolic profiling results (Appendix 1) for both farms, showed that, in general, most of the parameters tested were within the optimal range most of the time. Periods of high NEFA levels were detected in which indicates a shortage of energy available, and the causes and implications of this are discussed in section 4.32. However, none of the indicators that might suggest a disease issue/ challenge were observed.

As a result, faecal and bedding analyses, which would have been triggered by metabolic profiling, were not carried out. However, one of the most important considerations for calving during housing is reducing the exposure of the new-born calf to infections when it does not have a developed immunity. Many challenges are ingested, leading to gastrointestinal infections, but also respiratory infections due to inhalation will occur. In an ideal world a calf would be born into a clean, dry environment which has not been exposed to previous infections. In the real world this is impossible to achieve, but we can go a long way towards this by considering hygiene, disinfection, and stocking levels within a shed. If possible, sheds should be mucked out every 3 weeks to reduce the level of infection. Lime and disinfectant can be applied at the time of fresh bedding application to help reduce moisture levels and infection load. It is important to place water troughs and drinkers in a well-drained place and ensure they are well maintained to reduce leakages onto bedding. It is also worth checking the water source for drinking, and if not mains water, sample regularly for microbiology as well as minerals.

4.2.2 Parasites

Rumen fluke

Evidence of rumen fluke was seen in some samples taken on Farm A, but not at levels that are likely to have had an impact on performance and general health. Details can be found here (COWS: Control of liver and rumen fluke in cattle), but in key points from this guidance document are as follows: Rumen fluke have a worldwide distribution and are considered to be important parasites in a number of ruminant species, particularly in tropical and subtropical areas, but have been found increasingly in British and Irish livestock over the past ~5 years. Generally, mature rumen fluke do not cause clinical disease. Where disease has been reported, it has invariably involved large numbers of immature rumen fluke in the intestine, usually the duodenum, and typically in young stock. This results in severe enteritis characterised by ill-thrift and profuse, fetid diarrhoea. In severe cases, it has proved fatal, in both cattle and sheep. Whilst the clinical importance of rumen fluke is under debate, these parasites are significant from a diagnostic perspective. Liver fluke and rumen fluke are often found as co-infections and, because their eggs are similar, this could lead to misdiagnosis and/or misinterpretation of liver fluke treatment outcome. A differential diagnosis is important because there are only a small number of flukicides that can kill rumen fluke. Treatment of livestock for rumen fluke, in the absence of confirmed clinical signs, is not recommended. Only one flukicide, oxyclozanide, has reported activity against adult and immature rumen fluke, although none of the commercial flukicides containing oxyclozanide, either on its own or in combination with levamisole, have a specific label claim for rumen fluke.

Liver fluke

There was no evidence of Liver fluke seen. However, it is crucial to be regularly sampling at strategic times throughout the year to monitor faecal egg counts for gut parasites, as well as performing checks for liver and rumen fluke, and lungworm. Considerations of weather, season, forecasts, and risk levels should be made to create individual testing and treatment strategies for an individual farm. Further guidance can be found here (AHDB: Liver fluke control in grazing livestock).

Purchased animals should be quarantined and treated appropriately to reduce the risk of resistant parasites coming into a farm, testing can be worthwhile to check for possible new parasites not already being controlled (Forbes, 2018).

4.24 Antibiotic use

Farm A's results show a reduction in usage over time. Closer monitoring of results and review more timely would have allowed better target setting and reduced usage further potentially. However, changes in classes help to reduce caution usage antibiotics, less used overall indicates better health and fewer issues. Generally the vet and farmer working on issues has led to lower usage.

4.25 Vaccinations

Monitoring of diseases in a herd is important to ensure appropriate protection and control measures are used. Many herds are now testing for BVD and some for Johnes. Many herds vaccinate for BVD and Leptospirosis, as in the case of the project participants. Establishing herd status for diseases and developing a control plan in consultation with vets is a kay approach to minimising losses. Establishing status of the herds from which cattle are purchased is also vital for good biosecurity and biocontainment on the farm to avoid bringing in diseases on to the farm. Other diseases, such as Blackleg and other clostridial infections are ubiquitous and could potentially occur in any herd at any time. For cattle grazing it is worthwhile vaccinating for potential clostridial infections regardless of whether cases have been seen. The risk increases if there is exposure to soil such as when drainage work or building work has occurred, or in a very dry year.

4.3 Nutrition

4.31 Colostrum absorption in calves

The results of the colostrum absorption/ Zinc Sulphate Turbidity (ZST) tests are shown in Appendix II.

Optimising colostrum and milk when a calf is born has a positive impact on the calf through to weaning. In suckler herds there is often a reluctance to feed pre-calving due to risk of over-sized calves being born leading to calving difficulties and subsequent losses. Many herds therefore suffer from failure of passive transfer of antibodies in the colostrum which provide the essential first protection to the calf after birth until it has built up its own immune protection. If a calf receives adequate quantities of good colostrum then it has a chance to build up immune protection, the first 3-4 days of life are critical, especially the first 4-6 hours. Over this period the colostrum provides immunoglobulins to give general protection as well as local protection in the gut. With the calf gaining protection it becomes less susceptible to infections and therefore less likely to need any antibiotics.

Farm B showed adequate colostrum absorption throughout the project. Farm A has some calves that have shown inadequate absorption. Farm A does not provide any supplementation prior to calving to support milk and colostrum production other than silage. Some of the cows are dairy cross cows and so may have lower quality colostrum depending on breed and age. Farm B has limousin cows who will produce less milk quantity but probably of better quality. He also offers a supplementary bucket prior to calving.

Colostrum quality and quantity tends to improve between 1st parity cows and 2nd/3rd parity cows but then can start to wane as cows get older, after 5th/6th parity. Dairy cross breeds tend to give higher absorption but this is usually due to a bigger quantity being available rather than better quality of colostrum. Breeds generally will not be a selection choice for colostrum, but maternal EBV figures are crucial for milk production and therefore colostrum available for the calf.

4.32 Cow Nutrition

The animals have a requirement for energy and protein. These requirements meet the needs of maintenance, growth, lactation, pregnancy, fertility and health. If an animal's requirements are not met adequately then the immune system is less effective which increases the risk of infections and therefore antibiotic usage. Meeting requirements and maintaining body condition at the ideal level ensures the animal has the best chance to stay healthy.

The silage results are crucial to understanding the base diet. The parameters shown on the analysis are fed into a diet programme which calculates the energy and protein and other factors depending on the dry matter intake of the animals.

Feeding a shortage or protein and/or energy will increase the risk of mobilisation of body reserves, fatty liver, and poor milk/colostrum production and quality. Low blood urea results show a lack of effective rumen degradable protein (ERDP) supply to the rumen microbes,. This reduces the ability of the microbes to multiply and provide the source of protein required for the cow to look after herself, support her immune system, and produce colostrum and milk. If the cows were short of protein throughout the winter, they would have low Albumin results as well

The silage analysis results and the pre and post calving diets developed on the basis of those results are shown in Appendix III and Appendix IV respectively.

Herd B had lower protein forages, generally, and these cows showed low urea. Herd A varied with their results but generally the forage was slightly higher protein, and some feed was supplied from calving. The information was not available as to the calving date of the cows tested to check timing from testing to calving. Herd A had a period of high NEFAs which indicates a shortage of energy available to the cow and this corresponded with them running out of supplementary feed. Herd B showed higher NEFAs when sampled in July so this may have been related to grass quality and availability but unfortunately this information is not known.

The forage analyses for both these herds demonstrated good supply of micro-minerals. There are also high levels of antagonists, such as aluminium, iron and manganese in the forages which may be affecting availability of some other minerals. The blood results for Herd A showed good levels of micro-minerals other than manganese. There were no results for Herd B. It is essential that blood levels are checked at a time when the cows are at baseline nutrition to determine whether supplementation is required. It is useful for copper to check liver storage for a more accurate picture of status and therefore the need for supplementation (Bone, 2007). Although, micro minerals are often the focus from a farmer perspective, they are usually the final detail required for performance and therefore checking energy, protein and then macro-minerals is much more beneficial, although may seem harder to address or understand.

On Farm B one sample showed adequate nutrition for a pre-calving cow, the second was lower in nutrient value and therefore the protein level is tight. This could have impacted on colostrum quality and quantity. Supplementation with some quality protein and energy would support that colostrum and then milk production. The better the colostrum supply to the calf the better its immune system and therefore the lower risk of disease and less requirement for antibiotics. Silage alone is unlikely to meet full requirements and therefore increases the risk of issues occurring. This is very dependent on the silage quality though as higher protein silages incorporating a lot of clover will be more likely to be adequate on their own.

4.4 Soil nutrient status

With suckler herds being very much forage-based production systems understanding the soil is a priority as it is arguably the greatest natural resource present on these farms (Scamell, 2006). The key minerals in soil impact on the cation exchange capacity (CEC) of the soil. The higher the CEC, the greater its ability to hold nutrients and therefore grow stronger plants due to stronger roots. The balance of the cations: calcium, magnesium, hydrogen, sodium, potassium, zinc, copper, manganese, and iron are important for soil function. Calcium should make up 60-70%, Magnesium 10-20%, Potassium 3-5%, Hydrogen 10-15% and other bases 2-4%. Calcium helps open a soil up, magnesium pulls it together. Where magnesium levels are high, and pH is low the recommendation is to apply calcium carbonate lime. This would be the case for both farms in the project. Improving soil structure will not only improve forage growth potential but will also help reduce the antagonist minerals present, therefore increasing availability of other minerals in the forage.

The soil pH will affect the key nutrients. Low soil pH locks up the nutrients in the soil and therefore reduces the uptake into the plant. This therefore has a negative result on both plant growth and nutrient uptake.

The lower pH in the soil for Farm A is likely to have an impact on forage/grass growth and therefore will impact on the quantity of silage produced. This can lead to a restriction in forage being fed to cows which can then affect calving success rate, calf vitality at birth and cow condition impacting milk production. The requirement for concentrate is then greater. The results for these farms are very similar and to make real correlations from the data acquired would need a bigger dataset ideally.

4.5 Key performance indicators

The key performance indicators for the two participating farms are shown in Table 3.

KPIs are an important way of monitoring farm performance and highlighting areas to target for improvement as well as establishing things that are working well. While not all the information was available, we can identify areas that required support and the outcomes of some of the procedures on farm. Farm A had a very low % in calf rate in 2021 and this led to a low number of calves being born and reared. This was established as being due to an infertile bull on the farm. The bull issue was addressed for the following year and the % scanned in calf was much greater. The calving period for farm A was much shorter than that for farm B and this can have an impact on calf health and growth. A tighter calving period means a more targeted approach to feeding and grouping and this tends to make management easier and results in a more even bunch of calves being born. The average weight at weaning was greater in Farm A than farm B and this can be an indication of calf health and therefore colostrum provision from birth. The feeding on farm A may well have had the positive impact on this. The more cows calving in the first 3 weeks the stronger the calves are likely to be at weaning and the lower the infection pressure on these calves. Farm B had a greater % calving in the first 3 weeks but had a greater calving period spread. Both farms would benefit from reviewing the management prior to service period to increase this KPI. Cow mortality on both farms was low and this indicates general good cow heath and management. Replacement rate in herd A was high due to the need to bring more animals in with the lack of calves born and because replacements were not bred on the farm. Farm B has a higher culling rate but this is at a suitable level and matches the replacement rate indicating he can choose which cows to maintain to keep a healthy and productive herd.

	Farm A Spring 2021	**Farm A Spring 22**	**Farm B Spring 20**
Cow to bull ratio	22	15	24
% Cows scanned in calf	59	90	96
Calves born alive/100 cows put to bull	57%		100
Calves weaned / 100 cows put to bull	57%		100
Calving period	8.3 weeks		25.3 weeks
% Cows calving in 1st 3 weeks	48%		57%
Average weight at weaning	270		235
Empty cows and heifers	41%		4%
Cow mortality	2%		0%
Percentage of cows culled	5%		14%
Herd replacement rate	48%		18%

Table 2: KPI monitoring results

5. Key messages for farmers

- Monitoring of diseases is important to ensure appropriate protection and control measures are used, for example many herds are now testing for BVD and some for Johnes. Other diseases, such as Blackleg and other clostridial infections are ubiquitous and could potentially occur in any herd at any time.
- Establish your herd status for diseases and developing a control plan with your vet to minimise losses. If purchasing cattle, check the status of the herd you are purchasing from.
- Ensure there is good biosecurity and biocontainment on the farm.
- KPIs are important to give a base to allow farmers to compare yearly performance as well as against other farmers. Different KPIs can be more important to some farmers

rather than others but the ones we looked at in this study give a good overall impression of the suckler herd performance.

- Hygiene during housing is vital to reduce the exposure of the newborn calf to infections when it does not have a developed immunity. Sheds should be mucked out every 3 weeks to reduce the level of infection. Lime and disinfectant can be applied at the time of fresh bedding application to help reduce moisture levels and infection load. It is important to place water troughs and drinkers in a well-drained place and ensure they are well maintained to reduce leakages onto bedding.
- The calving period is crucial to the rest of the farm's productivity and profitability. Optimising colostrum and milk when a calf is born has a positive impact on the calf through to weaning. In suckler herds there is often a reluctance to feed pre-calving due to risk of over-sized calves being born leading to calving difficulties and subsequent losses.
- Supporting nutrition in the last few weeks before calving will help increase the ERDP supply, resulting in less body condition loss and better colostrum quality and quantity, improving calf health and performance.
- Forage analyses are important as a basis for developing pre and post calving diets.
- There is a direct relationship between soil nutrient status/ pH and the nutritional quality of silage. Good soil management is the foundation of good cow nutrition. It is important to test soil regularly and address nutrient deficiencies 'at source.'

Appendix I: Metabolic profiling results

	Below optimum range		Within optimum range		Above Optimum Range

Farm A

April 2021					
Sample	**Albumin g/L (Optimum 26-39)**	**Magnesium mmol/L (Optimum 0.7-1.3)**	**Urea mmol/L (Optimum 2.0-6.6)**	**BHB mmol/L (Optimum 0.00-1.2)**	**NEFA µmol/L (Optimum 0-600)**
1	37.3		4.1	0.4	183
2	36		3.9	0.41	198
3	37.3		4.8	0.55	330
4	33.2		5.2	0.37	202
5	31.5		3.4	0.45	154
6	36.5		5	0.4	141
7	34.4		3.9	0.38	127
8	35.7		3.5	0.35	179
9	30.6		3.7	0.42	150
10	32.1		3.5	0.28	184
11	33.9		4	0.46	170
12	34.5		3.8	0.39	194
13	34.8		3.3	0.45	157
14	36.4		4.4	0.45	179
15	35.1		4.5	0.52	182
16	34.6		4.3	0.37	104
17	34.7		3.5	0.38	202
18	28.9		4.1	0.32	131
19	30.2		2.7	0.36	133

May 2021					
ID	Albumin g/L (Optimum 26-39)	Magnesium mmol/L (Optimum 0.7-1.3)	Urea mmol/L (Optimum 2.0-6.6)	BHB mmol/L (Optimum0.00-1.2)	NEFA µmol/L (Optimum 0-600)
1	31.2		3.9	0.31	409
2	32.4		4.3	0.46	617
3	26.2		4.1	0.37	604
4	34.8		4.5	0.53	622
5	30.7		3.4	0.41	800
February 2022					
1	35.1	0.81	3.9	0.4	310
2	34.9	0.94	4.4	0.54	411
3	33	0.9	3.7	0.57	574
4	35.4	0.94	4.8	0.55	643
5	33	0.91	4.4	0.45	328
6	30.8	0.71	4.2	0.41	318
7	35.1	0.91	3.3	0.43	678
8	36.5	0.93	6.3	0.72	38
9	35.4	0.95	4.4	0.54	578
10	22.1	0.81	7.0	0.42	553
11	36	0.98	5.1	0.42	517
12	31	0.81	4.8	0.4	276
13	38.7	0.94	6.5	0.38	416
14	31.4	0.94	4.7	0.56	863

February 2022								
ID	**Calcium mol/L (Opt 2-3)**	**Globulin g/L (Opt 26-50)**	**Albumin: Globulin**	**Total Protein g/L (Opt 62-84)**	**Copper µmol/L (Opt 9-19)**	**Vitamin B12 Pmol/L**	**Manganese ug/L (Opt 15-20)**	**GSH-Px U/ml RBC (Opt >30)**
1	2.47	48.5	0.7	83.6	14.9	<111	12.9	85
2	2.37	36.3	1.0	71.2	13.2	<111	12.5	>105
3	2.45	38.4	0.9	71.4	14.4	<111	9.7	>112
4	2.29	36.4	1.0	71.8	12.5	<111	8.92	>109
5	2.39	36.6	0.9	69.6	15.3	180	10	95
6	2.31	55.4	0.6	86.2	12.7	<111	7.53	>127
7	2.44	40	0.9	75.1	16.2	<111	7.92	95
March 2022								
1					15.4			>97
2					16.0			>115
3					14.7			61
4					13.2			>100
5					14.0			>112
6					13.2			>100
7					16.0			>109

Farm B

Below optimum range	Within optimum range	Above Optimum Range

ID	Albumin g/L (Optimum 26-39)	Magnesium mmol/L (Optimum 0.7-1.3)	Urea mmol/L (Optimum 2.0-6.6)	BHB mmol/L (Optimum 0.00-1.2)	NEFA µmol/L (Optimum 0-600)
April 2021					
1	32.0	0.86	4.2	0.56	762
2	38.6	0.88	3.5	0.43	404
3	35.8	0.72	3.4	0.44	296
July 2021					
1	32.8		2.8	0.36	399
2	28.7		3.1	0.34	253
3	32.5		3.7	0.34	295
4	32.6		4.0	0.55	388
5	30.7		3.3	0.42	479
6	30.1		3.4	0.42	148
7	35.9		3.8	0.34	288
8	34.6		4.4	0.37	1312
9	28.4		2.6	0.5	679
10	35.5		3.1	0.37	442
11	30.1		3.3	0.38	726
12	33.5		3.5	0.37	611
13	33.2		3.7	0.76	642
14	31.8		2.1	0.37	345
15	25.4		4.4	0.32	244
16	36.5		3.4	0.32	661

Appendix II: Colostrum absorption (ZST) results

(red)	<4: Absolute failure of absorption	(amber)	5-19 : Relative failure of absorption	(green)	>20 Adequate intake

Farm A

ID	ZST Units			
	April 21	**May 21**	**March 22**	**April 22**
1	15.5			
2		22		
3			24	
4			14	
5			20	
6			14	
7				13.1
8				11.2
9				28
10				30.9

Farm B

	ZST Units	
ID	**April 21**	**May 21**
1	24.3	
2	26.5	
3		25.5
4		26.1
5		23.4
6		28.8

Appendix III: Silage analysis results

	Below optimum range		Within optimum range		Above Optimum Range

arm A

	14/12/20	1st cut 1 – 10/3/21	1st cut 2 - 10/3/21	15/2/22
Dry Matter %	60.6	53.9	58.6	33.9
Protein %	14.7	13.7	15.1	13.6
D value %	58.1	62.6	63	64.8
ME MJ/kg	9.3	10.0	10.1	10.4
pH	5.8	4.4	5.1	4.5
Ammonia N as % Total N	1.7	2.8	2.3	2.6
Sugars %	4.2	4.6	3.6	1.0
Ash %	6.5	8.0	7.8	6.7
NDF %	46	47.7	47.1	50.9
Digestible NDF%	69	60.8	70.4	78.1
ADF %	29.9	33.5	31.7	31.7
Lignin g/kg	37.1	50.9	39	28.3
Oil B %	4.4	2.9	3.7	3.8
VFA's g/kg	23.4	5.0	10.9	29.2
Lactic Acid g/kg	5.0	44.9	19.6	53.4
Intake g/kg	128.3	100.0	128.2	85.1
Calcium %		0.43	0.73	0.44
Phosphorus %		0.38	0.33	0.37
Magnesium %		0.24	0.16	0.19
Sodium %		0.51	0.25	0.38
Potassium %		1.88	2.57	2.17
Chloride %		1.04	1.00	1.12
Sulphur %		0.24	0.23	0.21
CAB meq/kg		255	341	272
Iron mg/kg		3225.8	125.9	477.7
Manganese mg/kg		220.2	112.4	253.6
Cobalt mg/kg		0.77	0.01	0.15
Zinc mg/kg		39.4	22.3	36.8
Selenium mg/kg		0.088	0.044	0.045
Aluminium mg/kg		3424.3	112.6	393
Lead mg/kg		2.65	0.05	0.64
Molybdenum mg/kg		0.95	0.48	0.49
Copper mg/kg		7.6	6.6	6.8
Cu:Mo Ratio		8.0	13.8	13.9

Farm B

	Below optimum range		Within optimum range		Above Optimum Range

	1/9/20 2nd cut	23/11/20 1st cut	17/2/21 2nd cut B	17/2/21 2nd cut A	4/2/22 cow	4/2/22 youngstock
Dry Matter %	35.2	35.4	66.5	59.2	51.6	63.2
Protein %	12.0	12.1	13.0	13.8	12.5	14.8
D value %	59	57	58.4	58.1	58	60.3
ME MJ/kg	9.4	9.2	9.3	9.3	9.3	9.6
pH	4.4	4.6	5.4	5.3	5.4	5.6
Ammonia N as % Total N	11.7	11.2	1.7	2.1	2.5	1.6
Sugars %	6	6.5	5.3	4.0	5.2	5.3
Ash %	6.4	7.1	6.4	6.5	6.5	6.8
NDF %	56.4	53.5	44.8	51	48.8	46.1
Digestible NDF%			69.8	55	77.1	87.5
ADF %			30.2	32.1	31.6	31.2
Lignin g/kg			34.1	55.1	29	20
Oil B %	2.7	2.8	3.0	2.9	3.9	4.2
VFA's g/kg	29.4	30.2	9.3	13.2	17.8	15.5
Lactic Acid g/kg	5.0	5.0	7.0	11.4	14.5	13.2
Intake g/kg	70	73	125.2	97.5	106.3	127.2
Calcium %			0.49	0.51	0.43	0.43
Phosphorus %			0.33	0.31	0.27	0.24
Magnesium %			0.25	0.26	0.22	0.21
Sodium %			0.65	0.49	0.47	0.54
Potassium %			1.48	1.2	1.11	1.41
Chloride %			0.99	1.17	0.73	0.98
Sulphur %			0.24	0.22	0.2	0.22
CAB meq/kg			232	52	159	184
Iron mg/kg			409.3	655.3	201	105.1
Manganese mg/kg			161.5	140.3	116.8	194.9
Cobalt mg/kg			0.1	0.31	0.08	0.11
Zinc mg/kg			22.3	32.1	20	26.7
Selenium mg/kg			0.12	0.065	0.12	0.19
Aluminium mg/kg			492.3	1101.7	128.7	68.7
Lead mg/kg			0.41	0.73	0.3	0.15
Molybdenum mg/kg			0.74	1.14	0.43	0.34
Copper mg/kg			7.3	8.0	5.3	6.6
Cu:Mo Ratio			9.9	7.0	12.3	19.4

Appendix IV: Pre and post calving diets

Farm A, pre calving

Diet name:	Suckler diet pre calving 21	Suckler diet pre calving 22
Animal details		
Breed	Aberdeen	Aberdeen
Feeding plan (kg as fed/head/d)		
Grass Silage -big bale	14.000	-
Big Bale Silage 2022 mins	-	25.000
Nutrients (units as stated)		
DM intake (kg/d)	8.5	8.5
Forage DM (kg/d)	8.5	8.5
ME (M/D)	9.3	10.4
ME (% req)	111	124
Protein (%DM)	14.7	13.6
DUP (%DM)	5.5	3.1
Starch plus Sugar (%DM)	4.2	1.0
Oil (AH) (%DM)	4.4	3.8
Calcium (%DM)	0.75	0.44
Phosphorus (%DM)	0.31	0.37
Magnesium (%DM)	0.16	0.19
DCAB (mEq/kgDM)	563	275
Potassium (%DM)	2.67	2.17
Sodium (%DM)	0.30	0.38
Copper (mg/d)	68	58
Cobalt (mg/d)	1	1
Iodine (mg/d)	1	1
Iron (mg/d)	1960	4049
Manganese (mg/d)	619	2149
Molybdenum (mg/d)	22	4
Selenium (mg/d)	0.8	0.4
Sulphur (g/d)	17	18
Zinc (mg/d)	238	312

Farm A Post Calving

Diet name:	Suckler diet post calving 21	Suckler diet post calving 22
Animal details		
Milk Yield (kg)	6.0	6.0
Breed	Aberdeen	Aberdeen
Milk fat (g/100g):	5.0	5.0
Milk protein (g/100g):	4.0	4.0
Feeding plan (kg as fed/head/d)		
Grass Silage -big bale	14.000	-
Big Bale Silage 2022 mins	-	25.000
DN Rolled Barley	2.000	2.000
Milkflow 18 Dairy Nuts	2.000	2.000
Nutrients (units as stated)		
DM intake (kg/d)	11.9	11.9
Forage DM (kg/d)	8.5	8.5
ME (M/D)	10.5	11.2
ME (% req)	120	129
Protein (%DM)	15.1	14.3
DUP (%DM)	4.9	3.2
Starch plus Sugar (%DM)	16.6	14.3
Oil (AH) (%DM)	4.8	4.4
Calcium (%DM)	0.68	0.46
Phosphorus (%DM)	0.34	0.39
Magnesium (%DM)	0.19	0.21
DCAB (mEq/kgDM)	405	200
Potassium (%DM)	2.13	1.78
Sodium (%DM)	0.28	0.34
Copper (mg/d)	120	109
Cobalt (mg/d)	3	3
Iodine (mg/d)	5	5
Iron (mg/d)	2386	4475
Manganese (mg/d)	783	2313
Molybdenum (mg/d)	55	37
Selenium (mg/d)	2.2	1.7
Sulphur (g/d)	26	27
Zinc (mg/d)	511	586

Appendix V: Soil Analysis

Below optimum range	(blue)
Within optimum range	(green)
Above Optimum Range	(orange)

Farm A

Analysis	Result 1 Grazing sheep	Result 2 Grazing sheep	Result 3 Grazing sheep	Result 4 Grazing sheep	Result 5 Grazing sheep	Result 6 Grazing sheep	Result 7 Grazing sheep	Result 8 Grazing sheep	Result 9 Grazing sheep	Guideline
pH	5.0 Low Req 6.0t/ha Lime	5.0 Low Req 6.0t/ha Lime	5.0 Low Req 6.0t/ha Lime	5.0 Low Req 6.0t/ha Lime	5.2 Low Req 5.0t/ha Lime	4.9 Very Low Req 7.0t/ha Lime	4.8 Very Low Req 7.0t/ha Lime	4.8 Very Low Req 7.0t/ha Lime	5.0 Low Req 6.0t/ha Lime	6.0
Phosphorus (ppm)	16 Normal (Index 2.0) Req 20kg/ha P205	23 Normal (Index 2.7) 20kg/ha P205	14 Low (Index 1.7) Req 50kg/ha P205	15 Low (Index 1.8) Req 50kg/ha P205	17 Normal (Index 2.1) Req 20kg/ha P205	12 Low (Index 1.3) Req 50kg/ha P205	11 Low (Index 1.2) Req 50kg/ha P205	12 Low (Index 1.3) Req 50kg/ha P205	14 Low (Index 1.7) Req 50kg/ha P205	16
Potassium (ppm)	137 Normal (Index 2.1)	136 Normal (Index 2.1)	103 Low (Index 1.7) Req 30kg/ha K2O autumn	97 Low (Index 1.6) Req 30kg/ha K2O autumn	165 Normal (Index 2.4)	108 Low (Index 1.8) Req 30kg/ha K2O autumn	139 Normal (Index 2.2)	141 Normal (Index 2.2)	170 Normal (Index 2.4)	121
Magnesium (ppm)	96 Normal (Index 2.9) Apply 25kg/ha MgO every 3-4 years	117 High (Index 3.2)	98 Normal (Index 2.9) Apply 25kg/ha MgO every 3-4 years	111 High (Index 3.1)	112 High (Index 3.1)	69 Normal (Index 2.4) Apply 25kg/ha MgO every 3-4 years	82 Normal (Index 2.6) Apply 25kg/ha MgO every 3-4 years	88 Normal (Index 2.7) Apply 25kg/ha MgO every 3-4 years	102 High (Index 3.0)	51

Farm B

	Below optimum range		Within optimum range		Above Optimum Range

Field	pH	P	K	Mg
1	5.7	3	1	2
2	5.7	3	2	2
3	5.7	2	2-	3
4	5.7	3	2-	3
5	5.8	2	2+	3
6	5.7	1	2-	3
7	5.8	3	2+	3
8	5.7	3	3-	3
9	5.8	2	2+	4
10	5.5	4	2+	3
11	5.7	4	2+	3
12	5.8	3	3+	3
13	5.7	3	3-	3
14	5.8	2	2+	4
15	5.7	4	2-	3
16	5.8	4	3+	3
17	5.7	4	2+	3
18	5.7	4	3+	3
19	5.8	4	2+	3
20	5.8	4	1	3
21	5.8	3	3+	3
22	5.7	3	3	3
23	5.7	3	2+	3