afbi Agri-Food and Biosciences Institute

AFBI ON-FARM DAIRY EVENTS

12, 13, and 14 September 2017

Banbridge, Enniskillen and Newtownstewart

CONTENTS

AFBI Research - Driving Innovation in Northern Ireland Dairying

Welcome to the Agri Food and Biosciences Institute's 2017 roadshows "Dairy Innovation in Practice."

At these events AFBI researchers will be demonstrating the latest scientific solutions to current dairy sector challenges. This booklet provides greater detail of the underlying science and how it can be adopted on-farm to sustain and strengthen the local dairy sector.

The Northern Ireland dairy sector is one of the most important sectors within the local agri-food industry, accounting for around 22% of the food and drinks processing sector. Output from Northern Ireland dairy farms has increased by over 88% from 1980 to 2016, whilst dairy cow numbers have only increased by 17% over the same period, from 270,000 to 317,000 cows. This increased production has largely been obtained by increased yield per cow, with yield increasing from 4340 litres/cow in 1980 to 6950 litres/cow in 2016. The increase in production is mainly due to very significant increases in the level of concentrate feeding, with average concentrate use now over 2.5 t/cow compared to 1.0 t/cow in 1980. This has resulted in a considerable rise in production costs, whilst the contribution of forage to milk production has decreased. For example milk production from forage decreased from 3200 litres/cow in 2000 to around 1500 litres/cow in 2014, although it is encouraging to note that this has now increased somewhat to just under 2500 litres/cow in 2016. With concentrate cost per unit of energy over three times that of grazed grass and twice that of silage, feed costs have increased significantly.

The decline in global dairy markets from 2014 – 2016 created severe financial pressures for dairy farmers across Northern Ireland, with milk price below the cost of production. Whilst milk prices have improved significantly in 2017 it is important to control production costs and manage increases in milk output carefully, in order to ensure farm businesses are more resilient in the face of

future volatility. The most effective way of doing this is to ensure a strong focus on efficient grassland management, irrespective of the production system. One of the few natural advantages we have in Northern Ireland is our ability to grow high yields of grass (up to 15t DM/ha) at relatively low cost. We must capitalise on this natural advantage to the full if we are to remain competitive in the future. This applies whether cows are producing 5000 litres or 12000 litres per lactation. Furthermore, increased reliance on, and production from, grass and grass silage will make a major contribution towards addressing many of the environmental challenges which the industry faces. For example, grass-based systems can significantly reduce phosphorus loss to waterways and emissions of ammonia and greenhouse gases to the atmosphere.

The primary objective of this series of AFBI Dairy roadshows 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 in the areas of calf rearing, animal health, soil management, grass production and utilisation and winter feeding.

Looking to the future, new technologies will fundamentally change virtually all aspects of dairy systems in Northern Ireland. Automated milking systems are now commonplace on many farms and we can expect this trend to continue such as with the automation of feeding systems and manure management. Automation will also 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.

AFBI researchers have a clear vision and ambition for what needs to be done to enable the application of these technologies to local dairy systems – these developments will be essential to allow local farmers and businesses to thrive and prosper, whilst enhancing the overall environment. In order to ensure our research is relevant and focussed on industry issues, our researchers work closely in partnership with farmers and industry through our on–farm research programme and our extensive network of farmer co-researchers, in cooperation with AgriSearch.

This booklet contains a summary of ongoing dairy research at AFBI which is designed to support a more efficient and profitable dairy industry. I encourage you to discuss the work being presented with AFBI staff who will be available throughout the day.

I particularly wish to thank our host farmers Ian McClelland, Aidan McManus and David Hunter for hosting these AFBI roadshows and highlighting their differing approaches to achieving high levels of production from forage. The financial support from DAERA and EU grant funding and from industry levy, administered through AgriSearch, is gratefully acknowledged. Thanks are also due to staff from AgriSearch, the Ulster Grassland Society and CAFRE for their support for these events.

Sinclair Mayne (AFBI Chief Executive)

Host Farms

Background Description

Ian McClelland, Banbridge

Ian manages a 70 cow, autumn-spring calving herd at Creevy House Farm near Banbridge, Co. Down. Previously a beef enterprise, Ian began farming on the 40ha site in March 2015. The farm is currently investing in new dairy cow accommodation with the aim of increasing cow numbers by 30%.

The farm places a strong focus on grazing and silage management to reduce feed costs. In 2016 the herd averaged 8700 litres per cow, with over 3500 litres produced from forage. Cows are grazed full time during the summer months with a winter diet of grass silage blocks and in-parlour concentrate feeding. Ian is transitioning the herd to a tighter autumn calving profile and aims to achieve 4000 litres from forage and a herd average 9,000 litres per cow per year.

Aidan McManus, Enniskillen

Aidan farms with his father Kevin near Kinawley, County Fermanagh. Converting from a suckler beef enterprise, the farm entered dairying in 2011. Starting with 50 cows initially, herd size has now increased to 110 with cows yielding 7800 litres per cow in 2016, achieving 3356 litres from forage. Cows are housed full time with zero grazed grass offered during the summer months. In the first four months of the 2017 grazing season, the farm has yielded 11.4t DM/ha across the 21.5ha grazing platform.

In winter 2016 the farm installed two robotic milking machines and is currently in the process of transitioning from a predominantly spring calving profile to a 60:40 spring autumn split to maximise use of the robots. Having reached target cow numbers, Aidan is now focusing on improving farm efficiency targeting an increase in milk yield without further increases in concentrate use.

David Hunter, Newtownstewart

David works in partnership with his father John and manages a spring block calving herd on 40ha near Newtownstewart, Co. Tyrone. The farm converted from suckler beef and crops to dairy in 2011. The herd now consists of 80 Holstein Friesian and Jersey-cross cows averaging 6250 litres per cow, with 3750 litres produced from forage.

The farm places a strong emphasis on grassland management, with a target of achieving 14 – 15t DM/ha/yr consistently. During 2016, the grazing platform had an average growth of 14.7t DM/ha.

David has also invested in new laneways across the 20ha grazing platform to ensure flexible access to grazing paddocks.


EATON

Back to Basics in Calf Rearing

Steven Morrison

Key Messages

- Good colostrum management is vital for calf health, survival and long term productively.
- Calves that do not receive sufficient colostrum are 3 times less likely to survive to 4 months of age
- Calves that suffer ill health take longer to reach breeding weight; calve at greater than 24 months of age and cost an additional £175 or more to rear.
- Calves need to receive 8.5-10% of their birth weight of colostrum within the first hours of life. For a 40kg calf, this equates to 4 litres of colostrum.
- Not all colostrum is equal in quality – on-farm tools are available and useful for grading colostrum quality.
- Follow vaccination protocols to maximise their effectiveness against disease prevalence and to enhance immunity.
- Invest time in the design and delivery of effective colostrum management protocols to maximise the lifetime performance of your dairy heifers.
- Do not forget the importance of hygiene at calving, during colostrum collection and, milk feeding and within the calf house.

Introduction

Recent research conducted by AFBI on commercial dairy farms has shown that 1 out of 16 heifer calves born did not survive to 4 months of age. This is equivalent to a 6% mortality rate! Previous research has shown that having a good colostrum management plan in place can reduce this mortality by a third. So what is going wrong and how can this costly loss in livestock of high genetic merit be prevented on the farm?

Importance of the early immune system

The immune system is responsible for recognizing, resisting and eliminating health challenges. New-born calves have an immature immune system at birth since they are unable to receive maternal immunoglobulins (Ig) from the dam via the placenta. As a result, calves are reliant on passive immunity from

colostrum to help protect against disease challenges in early life. Successful passive immunity is dependent on early consumption of colostrum, otherwise known as beestings, and is vital to the calf to prevent failure of passive transfer (FPT).

This 'liquid-gold' not only contains high levels of fat, protein, minerals and other growth factors but is packed full off Immunoglobulins (Igs) with the most common being IgG. The elevated concentration of nutrients within colostrum compared to milk is shown in Table 1. The high energy and protein content of colostrum makes it the ideal feed in early life to nourish healthy calves, and should not be wasted. Pooling or sharing colostrum is not advised due to the dilution of concentrated nutrients and increased risk of disease transmission.

Table 1 Fat, Protein and Lactose concentration of colostrum and typical bovine milk

	Milk	Colostrum	Difference
Fat	4.0	6.4	+60%
Protein	3.2	14.0	+437%
Lactose	4.7	2.7	-43%

Why is timing of colostrum consumption so important?

Achieving a high level of passive immunity is a battle against time. Firstly, as shown in Figure 1, there is rapid decline in IgG concentration on subsequent collections of colostrum, with third milking samples containing 50% less IgG than the first milking i.e. colostrum quality decreases with time from calving. Interestingly, within this particular AFBI study, IgG concentration was unaffected by the inclusion of concentrates in the dry cow diet (Figure 1), however the yield of colostrum/transition milk collected during the first 8 milkings increased by over 20%.

Secondly, the calf's ability to absorb the Ig components declines within the first hours of life. From the moment a calf is born the ability for Ig absorption through the small intestine reduces and by 24 hours of age this function ceases to work. That is why colostrum must be consumed as soon as possible after birth to make the most of this window of uptake. It is still advised to feed colostrum beyond 24 hours to help provide local gut protection and also benefit from colostrum's high nutritive value.

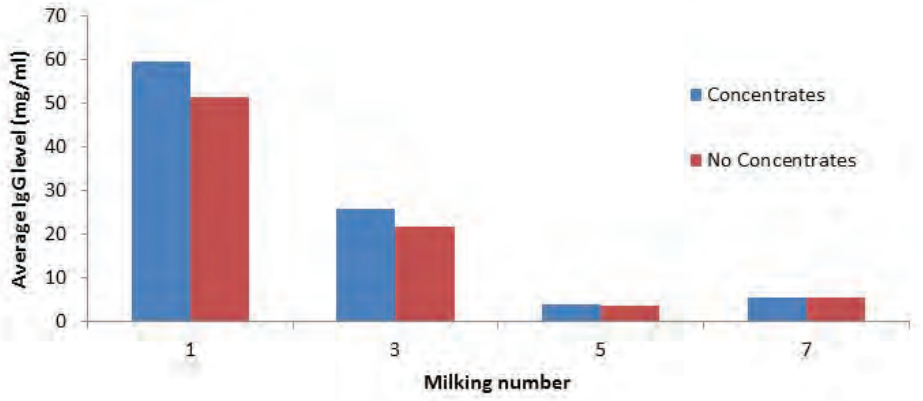


Figure 1 Immunoglobin G concentration in samples analysed by AFBI at milkings 1-7 from cows offered different dry cow feeding regimes.

What colostrum feeding methods are being used?

The advantage of feeding colostrum early and in significant volume, was highlighted by commercial farms involved in a recent AFBI study. On average across these farms, colostrum was fed within 3 hours from birth with 51% and 17% of calves fed using a stomach tube or bottle, respectively. Provided that producers are trained and competent in using stomach tubes, this is a positive development from the position back in 2006/7 were only 25% of dairy producers routinely fed colostrum using a stomach tube.

Additional research has demonstrated the increased risk of failure of passive transfer of immunoglobulins in calves left to suckle from the mother (Table 2). One study found that 61% of calves left to suckle from the dam had insufficient immunoglobulin uptake within 48 hours compared to only 19 and 11% of calves fed via nipple teated bottle or stomach tube, respectively (Table 2). This higher risk with suckling is largely as a result of delayed consumption of colostrum in sufficient volume and it is therefore recommended that colostrum is handfed via teated bottle or stomach tube.

Table 2. Studies showing failure of passive transfer of immunoglobulins in calves depending on the delivery of colostrum fed.

Reference	Percentage of calves showing failure of immunoglobulin transfer %	
	Suckle	Bottle
Beam et al. (2009)	26	17
Franklin et al. (2003)	38	13
Besser et al. (1991)	61	11-19

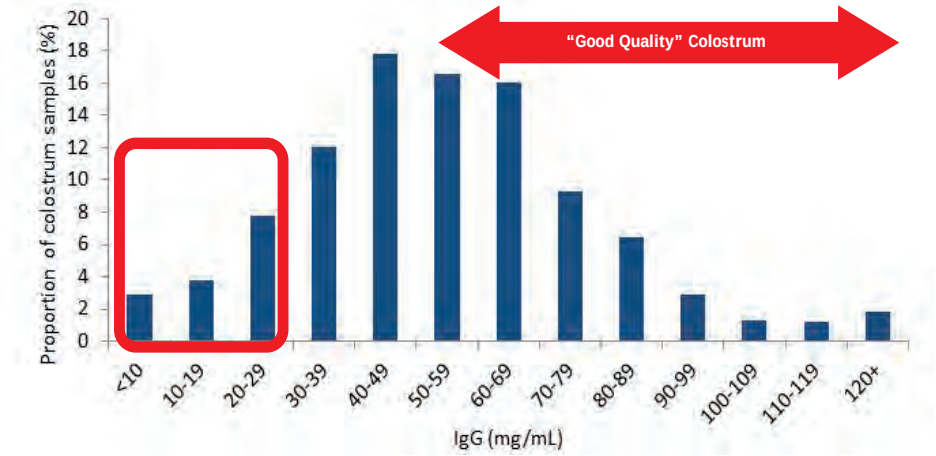
Not all colostrum is equal

In a first for Northern Ireland, colostrum quality was assessed by AFBI over a 1 year period on 21 commercial dairy farms. The nutritional quality of colostrum was highly variable with colostrum ranging from 1.9 to 13.2% in fat concentration and 7.0 to 19.9% in protein concentration. With 'good quality' colostrum often stated as containing over 50g Ig per litre, 56% of the 1239 samples were deemed good at this level as shown in Figure 2.

The key variables associated with increased colostrum quality were:

- Dry cow period greater than 8 weeks
- Colostrum collected less than 12 hours from calving
- Ig concentration increased by 30% from lactation 1 to lactation 5+

Figure 2. The distribution of IgG concentration (mg/mL) in colostrum samples from 1,239 dairy cows across Northern Ireland.



On average, heifers produced colostrum of adequate IgG concentration (50.8 mg/mL) with 44% of animals in their 1st and 2nd lactation producing high quality colostrum (> 50 mg/mL IgG). The average 1st milking colostrum yield from these animals was 5.4 litres. Consequently, 72% of the cows in their first and second lactation produced an adequate IgG yield to provide the calf with a minimum of 150 g of IgG to achieve a good passive immune status. This indicates that heifer colostrum should not be automatically discarded and should be tested for IgG concentration.

What about vaccination?

Vaccination of the cow pre calving is a strategy often employed to deliver pathogen specific antibodies in the colostrum. All cows within the survey had been vaccinated, with commonly used products including those aimed at scour causing pathogens such as *E. coli,* Rotavirus and Coronavirus. When tested by AFBI, vaccination of the dam did enhance the calf's ability to inhibit common pathogens. Adherence to vaccination protocols was found to be critically important, for example, pathogen inhibition levels were greatly reduced if cows were only vaccinated within 3 weeks of calving.

The time window between colostrum derived antibodies declining and the calf immune system maturing is a vulnerable period for calves in terms of protection against infection (Figure 3). It had been thought that high levels of colostrum derived antibodies could interfere with the calf's ability to develop its own active immunity to sub-cutaneous type vaccination in the first weeks of life. However, recent research in AFBI has shown this is not the case.

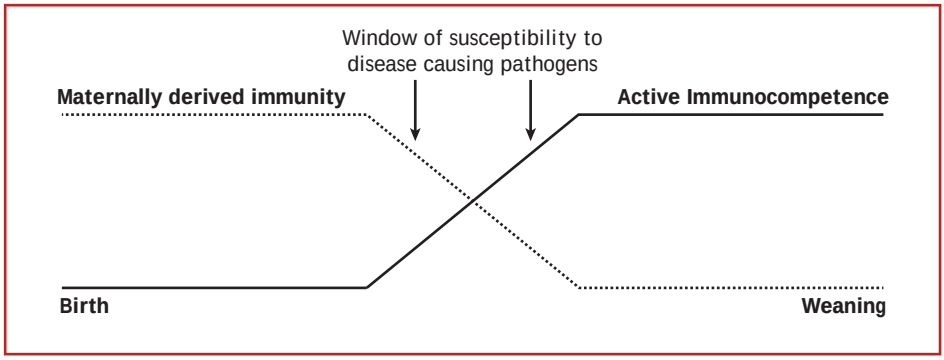


Figure 3. The process of acquiring full response to parenteral vaccines. Arrows indicate the window of susceptibility to pathogens where the calf is vulnerable to infectious diseases since neither the maternal immunity nor active immunity are at a sufficient level to prevent infection. (Adapted from Morein et al. (2002)).

AFBI researchers conducted a study to investigate if higher levels of colostrum feeding, therefore greater levels of colostrum derived antibodies, could interfere with vaccination. Calves having previously consumed either 5% or 10% of their birth weight as colostrum, received sub-cutaneous vaccination for bovine respiratory syncytial virus (BRSV) at 3 weeks of age and a booster 4 weeks later (see Figure 4). The findings from the study revealed:

a) The importance of the booster vaccine to stimulate a rapid protective immune response
b) No negative impact of feeding a higher level of colostrum on response to BRSV vaccination.

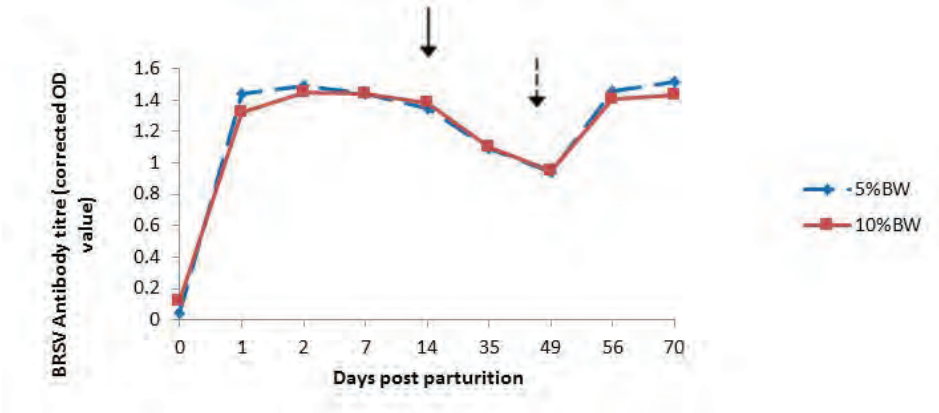


Figure 4. BRSV antibody circulating in calf sera post birth.
Solid arrow indicates time of primary vaccination, dashed arrow indicates time of booster vaccination with a multivalent respiratory vaccine

How to test colostrum quality?

AFBI research clearly shows the IgG concentration of bovine colostrum on Northern Ireland farms can be highly variable. With calves requiring upwards of 150g IgG within the first hours of life, variable quality can contribute to an inadequate intake of colostrum IgG, leaving calves at greater risk of ill health. Laboratory testing is considered to be the most accurate method for determining colostrum Ig concentration. This can be expensive, and results are not immediately available to inform decision making within the first hours of the calf's life. Therefore, AFBI conducted research to compare a range of techniques for estimating colostrum Ig concentration.

Colostrum samples were tested by laboratory and pen side based technologies. Both the refractometer and colostrometer (Figure 5) were able to correctly classify colostrum as achieving the 50g/L threshold 70-75% of the time and are therefore useful tools for identifying poor quality colostrum on farm.

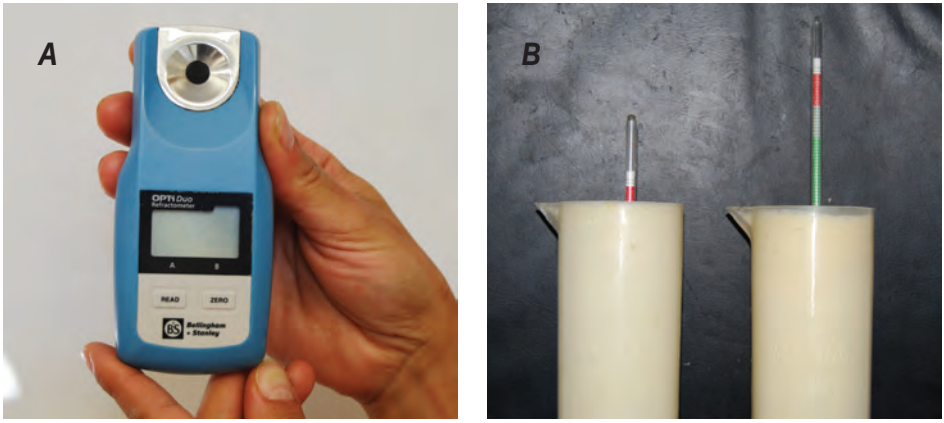


Figure 5. Image of the pen-side tests available to determine colostrum quality by A) Digital Refractometer or B) Colostrometer

How much colostrum do I need to feed?

AFBI on-farm research involving 21 farms, found on average producers fed 3 litres of colostrum to the calf during its first feed, however this ranged from 2.5 to 3.5 litres. The calf typically was offered colostrum for 3 days at between 2 and 3 litres per feed twice per day.

What are the benefits of feeding greater volumes of colostrum on calf health and performance?

Traditionally calves have been offered 2 litres of colostrum during the first feed. If left to suckle a calf would require 20+ minutes of continual suckling to consume 2 litres. A study conducted at AFBI found calves offered 5% of their birth weight (approx. 2 litres) almost immediately after birth had an immune status at 24 hours of age that was marginally above the minimum target level. In contrast calves offered 10% of their birth weight (approx. 3.5 to a maximum of 4 litres) had an immune status much greater than the minimum target level (see Figure.6). Research has shown positive impacts of a higher level of calf immunity in the first 24 hours including reduced mortality; reduced risk of calf scour; increased growth rate; reduced veterinary costs and increased 1st and 2nd lactation performance.

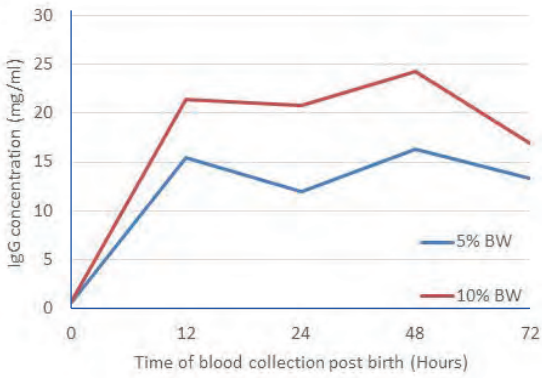


Figure 6. Variation in IgG concentration after calves were fed 5% or 10% Birth Weight in volume of colostrum

How do I assess how well I am managing colostrum?

Colostrum management when broken down into key steps is relatively simple: The 3 'Q's: feed Quickly; feed sufficient Quantity; feed Quality colostrum.

But how do you know you are getting things right?

There are a number of simple tests your vet can carry out which will quickly illustrate how successful your colostrum management is. Calves within the AFBI herd are routinely assessed for immune status using the zinc sulphide turbidity test (ZST). The ZST test is a proxy measure of the Ig concentration in the blood of the calf. The recommended target is a minimum score of 20 units with very high risk calves scoring less than 10.

Record incidents of disease, mortality and drug use. These simple records will help identify any patterns in illness outbreaks which may be linked back to colostrum management but will also highlight possible areas for improvement associated with housing, hygiene and management.

Colostrum hygiene

High levels of hygiene are critical for successful calf rearing.

Pre calving, ensure the calving pen and calving equipment are all clean and disinfected. AFBI on-farm research supported by research globally has shown routine cleaning of the calving pen (ideally between calving) reduces the risk of calf ill health. Disinfection and resting of the calving pen is also recommended. The cow's udder and teat should also be clean to prevent contamination of the colostrum or direct ingestion of bacteria by the calf when attempting to suckle.

After calving, it is important that colostrum is collected in clean containers since any bacterial contamination will multiply rapidly. If not fed soon after collection, colostrum should be stored in a covered container in the refrigerator. Figure 7 below demonstrates the rapid increase in bacterial presence when colostrum was stored at 12°C compared to 4°C over 96 hours within a recent AFBI study. Pasteurization can help reduce the bacterial load.

Colostrum should be heated to 38-40°C in a water bath no more than 30 minutes before feeding it to the calf. All feeding equipment including buckets, teats and tubes should be cleaned thoroughly prior to use. Follow the RINSE, SOAK, SCRUB, WASH, RINSE and DRY procedure recommended by AHDB and demonstrated on their website www.dairy.ahdb.org.uk/technical-information/youngstock/colostrum-hygiene/#.WY3b5ssUkeE).

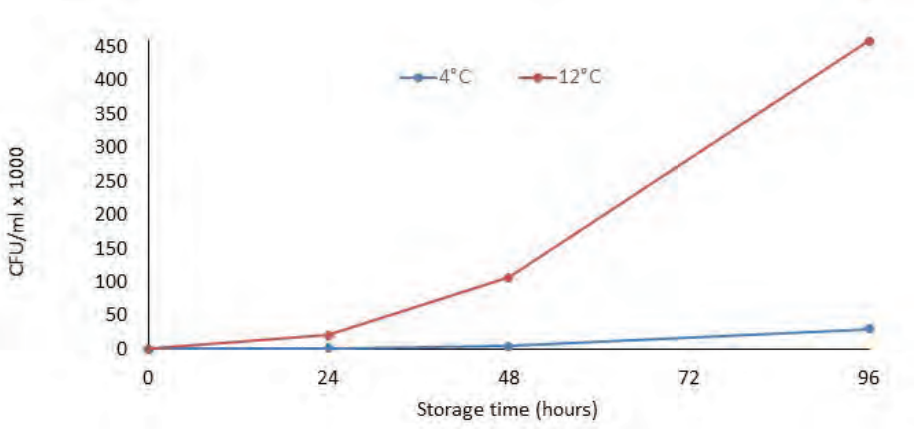


Figure 7 The rapid increase in bacteria count in colostrum when left unrefrigerated at 12°Cect of the temperature storage on the bacteria (colony forming units/ml) present in colostrum

Calf house/pen hygiene

Once calved, it is important to ensure the collection and removal of the calf from the calving pen to the rearing facility is also conducted in a clean and hygienic manner. Remember these calves have a very weak immune system. Calf pens should be disinfected and dried out for as long as possible between calves or calf groups. Sand can be put down under straw to help maintain a dry environment and pens should be bedded daily with extra straw for warmth and comfort. Regularly conduct the knee test – kneel down and rest your knee on the calf bedding. If your knee gets wet, additional bedding is required or the pen may require a total clean out.

Housing and pen design should create an ideal environment for the calf.

- A constant supply of fresh clean air is required but at a rate that does not create a draft at calf level. Air space rate of 0.1-0.2m/second at calf level is recommended which can be monitored using a simple and relatively cheap anemometer. Provided the air moving through the house is fresh, in practice this should result in little or no smell within the house.
- A wet damp calf house, be it through the bedding or walkways, will create an ideal environment for pathogen growth. The evaporation of this moisture will also lower the temperature of the house which could reduce the energy available to the calf for growth.
- Monitor air temperature at calf height within the house as a drop in temperature from 15 to 5°C could reduce calf growth rates by 15-20%. During cold periods ensure plentiful bedding and it may be worth considering an increased level of milk replacer feeding or calf jackets on the youngest calves to help maintain desired growth rates.

Impact of getting it wrong

Poor colostrum management directly increases the risk of mortality within the first months of life. AFBI research on 17 commercial dairy farms across Northern Ireland found that calves that had low immunoglobulin status (34% of calves) were three times more likely to not survive until 4 months of age. Those surviving calves that suffered scour and pneumonia had lower growth rates and had an increased risk of delayed age at first calving. Similarly long term analysis of over 1800 dairy heifer calves based at AFBI Hillsborough found reduced growth rates, potential delayed age at breeding and reduced milk yields with calves that suffered ill health in the first 4 months of life (Table 3).

Table 3 Impact of calf ill health on longer term heifer performance (AFBI Hillsborough data based on 1881 calves)

	Pneumonia	Scour	Lethargic
Weight at weaning	-5kg	-4kg	-5kg
Weight at 18 months	-19kg	-12kg	-19kg
1st Lactation Yield*	-170 Litres	-33 Litres	-592 Litres

Preliminary data*

Each day of delay in calving beyond 24 months of age costs £2.87 per heifer (AHDB). The reduced growth rate and hence increased risk of delayed breeding and therefore calving associated with calf health, could increase

heifer rearing costs by £175 or more. Add on potential reduced levels of performance once the heifer joins the dairy herd and the impact of poor early life management becomes very significant.

Summary

Rearing dairy heifers is a major financial investment, with CAFRE Business Development Group Benchmarked costs averaging £1,768 per heifer. AFBI research has clearly shown the impacts of good early life management on reducing the risk of calf mortality and ill health. Through setting in place and following calf management protocols (see Checklist) calf losses can be minimised and heifers reared to achieve their genetic potential. Successful calf rearing is firstly about getting back to basics and thereafter it involves paying strict attention to detail!

Checklist

- ☑ Calving and colostrum management plan in place
- ☑ Feed 8.5-10% of birth weight of colostrum within first hours of life
- ☑ Colostrum quality tested routinely
- ☑ Calf immune status routinely assessed
- ☑ Calf health records kept and routinely reviewed
- ☑ Calf health and strict biosecurity plan in place and followed

Investing the time in designing and delivering an effective new-born calf management protocol will help maximise the lifetime performance of your dairy heifers

For further information on the calf and heifer rearing research programmes contact:
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PerkinElmer

Cattle Health Scheme, Calf Health and Cattle Abortion

Jason Barley, Helen Gibney and Maria Guelbenzu

Key Messages:

- AFBI's Cattle Health Scheme includes programmes for routine monitoring, disease reduction, disease eradication and disease free accreditation for five of the most important non-statutory diseases in beef and dairy herds in Northern Ireland.
- Calf health is an important aspect of dairy herd health planning. Adequate colostrum intake, good hygiene and biosecurity and vaccination are important tools in managing calf health.
- Abortion in cattle is a significant cause of livestock wastage and is caused by both non infectious and infectious agents. The incidence of abortion can be reduced by good hygiene and biosecurity and vaccination against potential causes of abortion should be considered in high risk situations.

Improving Farm Profitability with the AFBI Cattle Health Scheme

AFBI provides a Cattle Health Scheme (CHS) which details protocols for the monitoring, control and eradication of some of the most economically important diseases of cattle, including infectious bovine rhinotracheitis (IBR), bovine viral diarrhoea (BVD), neosporosis, leptospirosis and Johne's disease. Certification is also provided when a herd meets the agreed standards. The Scheme is licensed by, and operates to Cattle Health Certification Standards (CHeCS), the regulatory body for Cattle Health Schemes in the UK and Ireland. This is a non-trading organisation established by the cattle industry for the control and eradication of non-statutory diseases using a set of standards to which all licenced schemes must adhere.

In addition to testing requirements, herd biosecurity is a very important component of disease control programmes. A key benefit of the AFBI CHS is the emphasis on sound biosecurity practices. These include the requirement for double fencing (or an equivalent gap of at least 3 meters between animals

and any neighbouring stock) for the accredited schemes for IBR and BVD, or that a compulsory vaccination programme is in place in the absence of double fencing for the vaccinated monitored free schemes for those diseases. There are rules regarding the isolation and testing of any newly introduced animals into the herd and these also apply to 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. Improved biosecurity is effective against the introduction and spread of most pathogens, as well as limiting the spread of disease within the herd and hence financial losses.

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

The programmes may be used for routine monitoring, disease reduction, disease eradication and for disease free accreditation or risk level certification. The programmes are:-

1. Bovine viral diarrhoea (BVD)

BVD is a pestivirus infection of cattle which causes a variety of clinical outcomes. The most important of which interfere with reproduction, affecting the foetus and can lead to persistent infection and the fatal 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 is a highly contagious disease of cattle caused by bovine herpes virus 1 (BoHV-1). It 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

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 Polymerase Chain Reaction (PCR).

For dairy herds there is a risk level reduction programme, aimed at reducing disease prevalence over time. 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.

In participating herds, breeding females over the age of two are tested annually.

AFBI Cattle Health Scheme members who progress towards accreditation and risk level certification enjoy a number of benefits but most importantly they are protecting the health, welfare and profitability of their herd.

For further information contact:

The AFBI Cattle Health Scheme Team
Veterinary Sciences Division
Stoney Road, Stormont
Belfast BT4 3SD
Telephone: 028 9052 5749
Email: cattlehealthscheme@afbini.gov.uk

Health and Welfare Planning for Young Dairy Calves

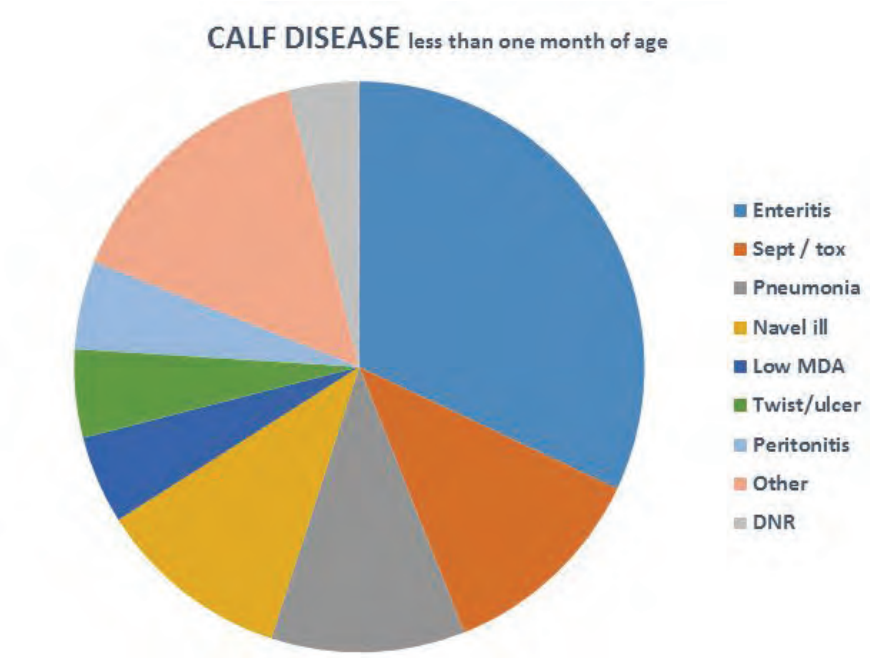
Introduction

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.

Calf diseases

Figure 1 shows a schematic representation of the most common causes of death diagnosed by the AFBI laboratories in young calves in Northern Ireland

Figure 1. Most common causes of death diagnosed in young calves in Northern Ireland



The three key factors in good calf health and welfare are, accommodation; feeding of colostrum; disease prevention by vaccination. Guidance on how best to address these issues are as follows:

Accommodation

Calving accommodation must be hygienic and available in sufficient quantity to prevent over-use and allow proper cleaning and disinfection. Over-use of too limited calf accommodation 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 and are vital in preventing diseases such as navel ill / joint ill.

Important features of calf rearing accommodation include:

- 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.

(Source: AFBI VSD booklet: Health and Welfare Planning for Young Dairy Calves)

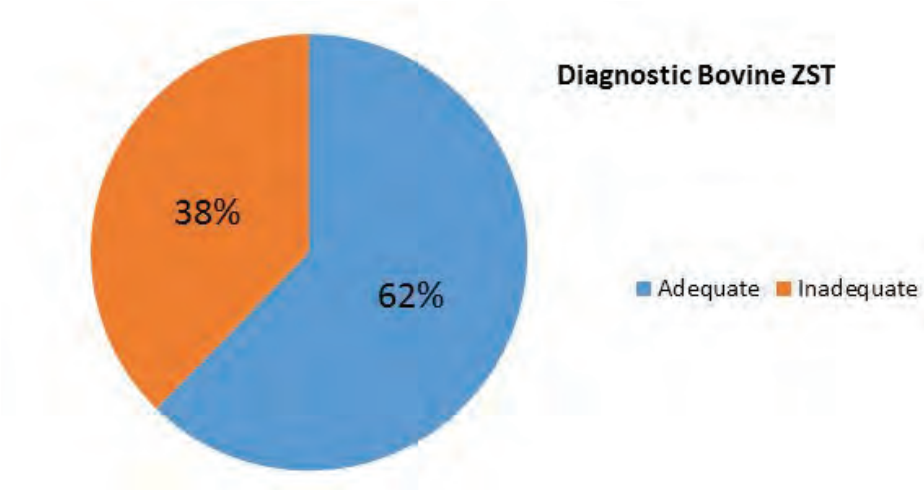
Feeding of colostrum

Feeding of colostrum is covered in detail in other sections of this booklet and during the on-farm presentations. This section highlights the problem of achieving adequate transfer of maternally derived antibodies to calves which currently exists in Northern Ireland and Ireland.

The Zinc Sulphate Turbidity (ZST) test is an indirect measurement of the passive transfer of immunoglobulins (antibodies) via the colostrum from the dam to the young calf. The adequate delivery of good quality colostrum is an important part of calf management. This transfer of immunity provides protection to neonatal calves from common infectious diseases that contribute to illness and death.

Failure of passive transfer is best assessed on a herd basis. It is recommended that multiple (up to twelve) samples be taken from healthy calves less than a week old for testing. Figure 2 shows the results of zinc sulphate turbidity tests performed by AFBI and DAFM laboratories in 2016 from submitted bovine calf serum samples. Adequate colostral immunity is defined as greater than or equal to 20 units and inadequate as less than 20 units.

Figure 2: Zinc sulphate turbidity tests 2016 (total number of samples =1199, source: All island Disease Surveillance Report 2016: in press)



During 2016 a combined total of 1199 ZST tests were performed on bovine samples submitted by private veterinary practitioners. Around 38 per cent of these samples had values less than 20 units indicating a failure of passive transfer indicating that **almost 40% of young calves had inadequate colostral protection.**

Disease Prevention by Vaccination

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 while Rotavirus is also commonly identified. Low levels of colostral antibodies were recorded in a high number of dead neonatal calves in Northern Ireland which underlines the role played by appropriate colostrum managementin the first 24 hours of life 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 of cows and possibly calves as well. In this context, it is important to plan the herd vaccination programme with your veterinary surgeon.

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 receives adequate amounts of colostrum. Here again it is crucial to plan the herd vaccination programme with your veterinary surgeon.

For further information on calf health and disease diagnosis, contact:
Jason Barley, email DSIBsample.enquiries@afbini.gov.uk, 44 (0)28 9025 5649

Cattle Abortion in Northern Ireland

Abortion in cattle is a significant cause of livestock wastage that is also costly as a single abortion in a dairy herd will amount to several hundreds of pounds in lost potential. Abortions can occur in any herd, often at around 1 to 2%, but once the incidence exceeds 3-5% or several abortions occur in close succession, there may be cause for greater concern. So 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 divided into non-infectious and infectious.

Common causes of abortion in cattle in Northern Ireland

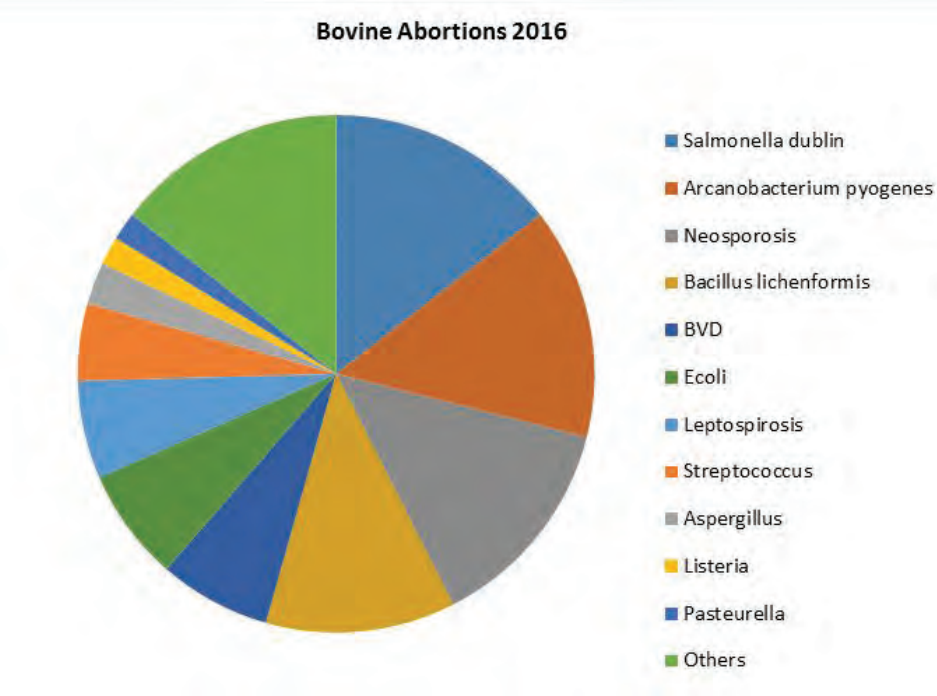
Figure 3 gives a summary of the causes of bovine abortion diagnosed in Northern Ireland during the period January to December 2016.

Specimens from 430 bovine abortions and stillbirths were examined during 2016. Significant pathogens were detected in 190 cases (44.2 %). Of these, *Salmonella* Dublin (33 cases, 7.7 %) and the bacterium *Trueperella pyogenes* (33 cases, 7.7 %) were the most commonly identified pathogens. Other pathogens identified included neosporosis (*Neospora caninum* (31 cases, 7.2 %),

Bacillus licheniformis (27 cases 6.4%), *Escherichia coli* (16 cases, 3.7 %) and bovine virus diarrhoea virus (16 cases, 3.7 %).

It is also very important to remember that all cattle abortions should be reported to DEARA in case brucellosis investigation is required

Figure 3 Causes of bovine abortion diagnosed in Northern Ireland (Jan-Dec 2016)



Investigation of cattle abortion

Diagnostic Submissions from Bovine Abortions

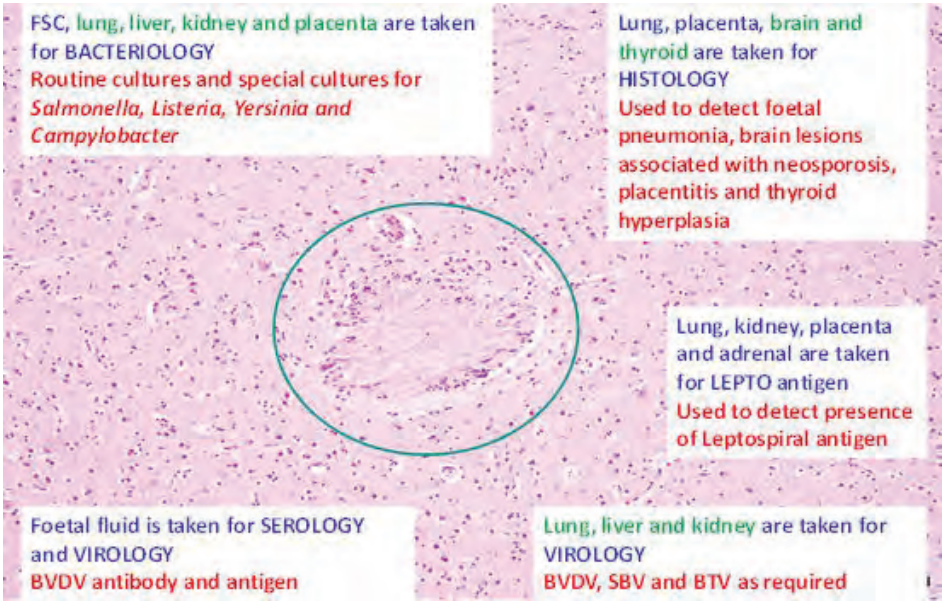
Investigation of abortion requires input from the farm veterinary surgeon **AND THE SUBMISSION OF MATERIAL TO THE DIAGNOSTIC LABORATORY**.

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 are the best diagnostic samples and a representative number of abortions should be submitted. Inadequate samples compromise diagnosis and waste money. Placenta and foetal stomach contents (FSC) are best if a full submission is not possible.

Sampling is extensive in the AFBI diagnostic laboratories: lung, liver, kidney, FSC, placenta, adrenal gland, foetal fluid and brain are taken for bacteriology, serology, virology and microscopic examination (histology). Additional samples may be taken in special cases.

FIGURE 4 below emphasises the extensive testing undertaken.



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 potential causes of abortion such as BVD and IBR onto the farm. 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 member 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.

For further information on abortion in cattle herds, contact:
Jason Barley, email: DSIBsample.enquiries@afbini.gov.uk, 44 (0)28 9025 5649

Looking After Your Soil

Suzanne Higgins and John Bailey

Key Messages

- Healthy soil supports healthy grass and animals since it provides the nutrients and water required for optimum grass growth
- Soil test every 4-5 years
- Soil pH 6.0 is recommended for continuous grassland
- Monitor nutrient inputs to ensure the correct balance. Nutrient surpluses can be as harmful as nutrient deficits
- Slurry is a valuable source of nutrients
- Don't forget about Sulphur
- Careful management is needed to avoid compaction There are a number of key components to consider when managing soil health and structure. These are outlined below.

Soil Testing

A soil that is deficient or unbalanced in nutrients will not produce optimum grass yields or good quality silage. A soil test every 4-5 years is necessary and will provide you with advice on future fertiliser and lime requirements. Likewise, where nutrients are in good supply, soil testing will prevent you wasting money on unnecessary fertiliser.

How to soil test

- Follow a zig-zag W-shaped sampling pattern across the field (Figure 1)
- Collect 20-30 cores per field with a 3 inch auger to form a bulked sample (Figure 2)
- Avoid gateways, dung and urine patches, drinking troughs, headlands and animal resting places
- If a field is larger than 10 acres, split it into two and collect 20-30 cores from each half
- Sample between October and early March, at least 4 weeks after applying fertiliser or slurry.

Cost

The cost for standard soil analysis is approximately £1.86/ha or 75p/acre. Additional labour costs to conduct the sampling increases the cost to approximately £5/ha or £2/acre. These costs are minimal in comparison to the price of purchased fertiliser, which can be over £200/ha (>£80/acre), depending on the formulation.

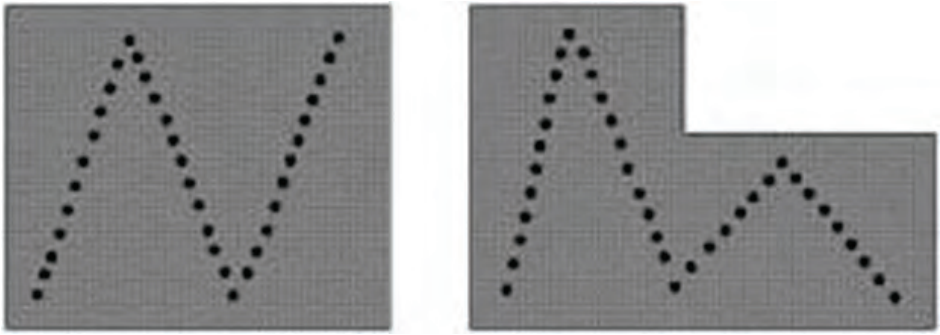


Figure 1. Examples of the zig-zag sampling approach

Figure 2. Soil sampling with a 3 inch auger

Lime

The application of agricultural lime has long-term benefits for soil fertility. Regular and targeted application makes a substantial difference to the productive potential of grassland. Soil pH 6.0 is recommended for high-yielding perennial ryegrass with white clover swards. AFBI research has shown that more than 50% of grassland in Northern Ireland is under-limed (pH < 6.0) and is losing up to 2 t DM/ha/yr in growth as a result.

Figure 3. Liming

By maintaining the soil pH around 6.0 with regular, lower doses of lime, AFBI research has shown that this is more beneficial than letting the pH fall too low and applying larger doses less frequently. Along with helping to maintain grass yields, mobilisation of nutrients such as phosphorus from soil stores was significantly improved when regular lower doses were applied. AFBI research has also shown that dolomitic lime is a useful source of magnesium in areas prone to grass tetany.

Given the investment made when re-seeding, always test the soil and apply the recommended dose of lime following reseeding. This will help maintain the vigor of the reseed.

Slurry

Slurry is a valuable source of nitrogen (N), phosphorus (P) and potassium (K) and if used wisely can reduce the quantity of additional chemical fertiliser required. The nutrient content of cattle slurry is known to be highly variable. Research has shown that the dry matter content of slurry is a good indicator of its nutrient value, and can help ensure the correct balance of nutrients are applied.

The closed period in Northern Ireland is between 15th October and 31st January and therefore a minimum of 22 weeks storage is required. The best time to apply slurry is between late February and April, at or just before the start of peak grass growth. Slurry applied at 3000 gallons per acre, together with 2½ bags/acre chemical N fertiliser (27% N) can potentially meet most of the N, P and K requirements for first cut silage.

DO'S AND DON'TS OF SLURRY SPREADING

WHEN APPLYING SLURRY REMEMBER THAT:-

- Cool, overcast or misty conditions are most favourable for slurry spreading
- Use low trajectory spreading techniques such as trailing shoe (Figure 4)
- Trailing Shoe reduces N loss, such as ammonia emissions to the atmosphere, and can improve yields by up to 25%
- Maintain a minimum of 3 weeks between applications
- The total amount of N applied in livestock manure should not exceed 170 kg N ha/yr (250 kg N/ha/yr if derogated).

DO NOT APPLY SLURRY IN THE FOLLOWING CONDITIONS

- Do not apply slurry on hot days with no wind, as this will increase ammonia losses
- Do not apply slurry if heavy rain is forecast within 48 hours
- Do not apply slurry when land conditions are unsuitable
- Do not apply slurry to areas within a field that might be waterlogged or have a high risk of runoff into waterways
- Do not apply more than 50 m^3/ha (4500 gal/acre) or 50 t/ha (20 t/acre) at one time.

Figure 4: Trailing Shoe slurry application

Soil/Slurry Nutrients

Nitrogen

Nitrogen (N) is a key driver of grass silage yields and while other nutrients must be in balance, it is essential that the demand for available nitrogen is met if the maximum yield potential of the sward is to be achieved. Research has shown that a perennial ryegrass silage crop can require around 2.5 kg/ha/day of N (2 units/day) during peak growth. If targeting a first cut yield of over 5 t/ha of dry matter (around 28 t/ha fresh) it will require 125 kg N/ha (3¾ bags/acre) applied around 50 days before cutting to ensure full growth potential and utilisation. Slurry plus fertiliser in Spring can provide ample nitrogen for first cut silage. The amount of N supplied by slurry will vary depending on its dry matter content and source (cattle, pig etc.).

AFBI surveys have found that N can often be in short supply at 2nd and 3rd cuts, with swards displaying signs of deficiency and not achieving their full yield potential (Figure 5).

The maximum amount of chemical N fertiliser permitted on dairy farms is 272 kg N/ha grassland (8¼ bags/ac) according to the EU Nitrates Action Programme and Phosphorus Regulations.

Figure 5: A grass silage sward displaying N deficiency at 2nd cut

Phosphorus

Phosphorus (P) is an essential nutrient for grass growth. Too little P will reduce grass yields but surplus P is harmful to the environment. AFBI research has found that 50% of soils on dairy farms in Northern Ireland are over-supplied with P and do not need additional chemical P fertiliser applications. Recent AFBI research has demonstrated that a reduced application of P fertiliser has resulted in improvements in water quality. However in recent years these improvements have levelled out. Farmers should be aware of the need to minimise P contents in concentrates to reduce the loss of P to waterways from associated slurry applications. Regular soil testing will indicate whether there is a requirement for phosphate fertiliser. Grass samples collected prior to silage cutting will also indicate the P sufficiency of the sward. New P recommendations for cut and grazed silage swards have been issued

(Phosphorus Regulations (2015)) with a revised target soil P Index for grassland of Index 2+ (21-25 mg P/l). Further details are presented in the article that follows, by John Bailey: *New Phosphate Management Protocols to Maximise Grass Production.*

Figure 6: Soil sampling (L) and grass sampling (R) will indicate P status

Potassium (Potash)

An adequate supply of potash (K) is also essential for optimum grass yields. Without a soil test every 4-5 years, K deficiency is not easy to identify. Yield losses can occur without any recognisable visual symptoms. A grass silage crop can remove 25 kg of potassium per tonne of grass dry matter harvested. Organic manures are a useful source of potassium and can provide a large proportion of potash requirements at relatively low cost. Along with yield benefits, having sufficient K present within the soil is essential to enable optimum nitrogen uptake and utilisation by swards.

Potash *deficiency* is common in NI. AFBI research has found 15 to 20% of 1st and 2nd cut silage swards to be deficient in potash and suffering dry matter yield losses of up to 30% as a result of low soil K levels. However potash overuse is also a problem, with more than 30% of farmland displaying surplus K levels with the potential to exacerbate animal health problems.

Care is required. High inputs of K in spring can reduce the uptake of magnesium. Magnesium deficiency results in Grass Tetany (hypomagnesaemia), which is a major cause of death in cows in NI, particularly suckler cows grazing Spring pastures. 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 K can be susceptible to milk fever following calving.

Sulphur

AFBI studies have shown that sulphur (S) deficiency remains a risk in Northern Ireland, particularly in Spring on light sandy / free draining soils with low organic matter contents, but it is also a problem on heavier textured clay loam soils. Many farms in NI display sulphur (S) deficiency, particularly in 1st cut silage crops (April / May). Yield losses of up to 30% are common at 1st cut or 1st grazing as a result of S deficiency. Slurry does not provide the full quota of S required by silage crops. Additional fertiliser S is required.

Ensuring an adequate supply of S will help optimise grass yields along with the correct nitrogen : sulphur ratio within the grass. Grass silage crops have a requirement of around 20 kg sulphur per hectare per cut and where required, 1 kg of S for every 10 kg of applied N is a general principle to follow.

Highly deficient swards can appear pale yellow-green in colour but 20% of dry matter yield loss can occur without any recognisable visible symptoms. Sulphur deficiency can also reduce the feeding value of grass, which results in reduced animal performance.

Sulphur is easily lost from soil during prolonged periods of wet weather. Therefore, sulphur-containing fertilisers should be routinely applied to all silage and grazed swards in Spring, including fields receiving slurry, and also at 2nd and 3rd cuts to shallow or sandy soils; or soils presenting a low soil S test result.

Soil Compaction

Soils become compacted through the repeated operation of tractors and heavy farm machinery within fields (Figure 7). Most farms will display some degree of soil compaction. A mildly compacted soil will normally recover naturally if the source of compaction is removed. Severely compacted soils (Figures 9 & 10) can take years to recover, and would require some targeted intervention, otherwise productivity will be greatly reduced.

A compacted soil is where the soil particles have become consolidated beyond an optimum level, making root penetration difficult and reducing soil aeration, water infiltration and drainage (Figure 8). Soil compaction can reduce grass yields by up to 25%.

Figure 7. Causes of soil compaction.

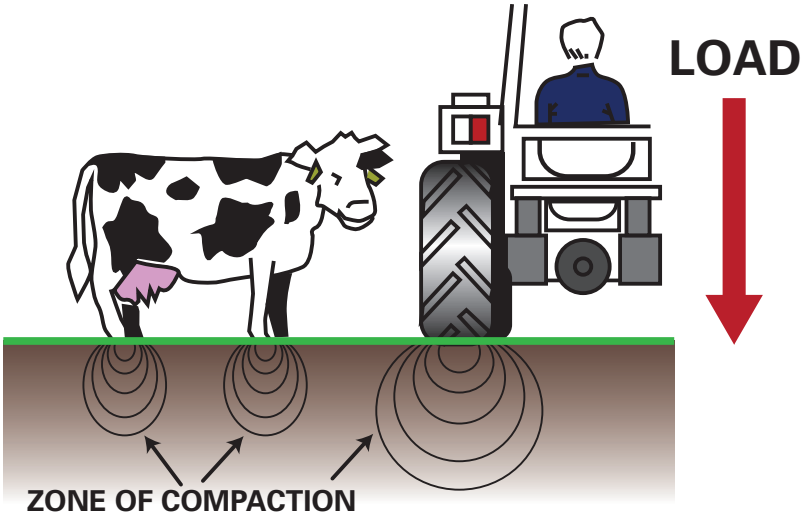
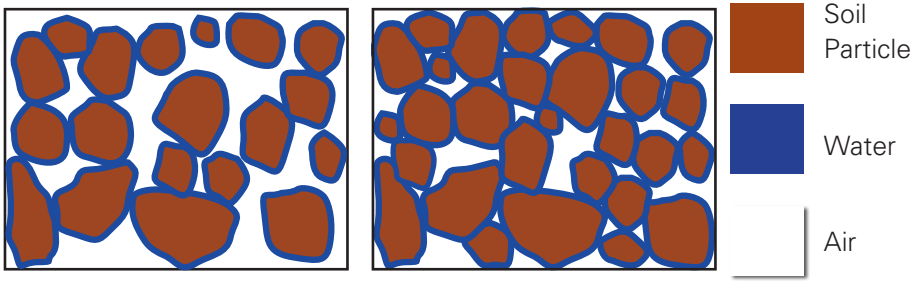


Figure 8. Illustration of soil compaction.



Wet soils are more vulnerable to compaction. Indicators of compaction include areas of surface water (ponding) following rainfall, suggesting reduced infiltration; patchy crop growth, which often coincides with wheel tracks and areas of heavy trafficking; and soil with a 'cloddy' appearance and often containing blue mottles (through lack of oxygen) (Figure 9).

Figure 9: A Humic Gley soil with a blue-grey subsoil, the grey colour indicating lack of oxygen

In severely compacted soils, ***subsoiling*** is undoubtedly the best mechanical way of relieving compaction, but 'blind' subsoiling, without prior soil examination both before and during the activity, may result in a poorly executed job of little or no value. Compaction can also be removed by using a mole-plough, aerating the soil or by cultivation.

Preventing soil compaction by careful management practices is by far a more cost effective strategy. Improving ***soil drainage*** and unblocking old drains will reduce soil wetness. Drains can become blocked frequently, particularly along hedgerows where tree roots can impede drainage channels.

'Slitting' the soil surface will improve infiltration and also free-up surface compaction.
New technology such as GPS-enabled Controlled Traffic Farming guides farm machinery along designated paths within the field, preventing machinery using the same tracks repeatedly, which is often a contributing factor to compaction. This technology can also reduce fertiliser wastage by minimising overlaps within the field.

Preventing or Reducing Soil Compaction
Compaction can be reduced or prevented by:

- Carefully managing the timing of field operations: keep off fields when very wet
- Reduce total axle loads (ideally below 5 t)
- Use large tyre diameter and width in combination with lower inflation pressure
- Restrict traffic to designated tramlines rather than fan out from access points

For further information on looking after your soil contact:
Suzanne Higgins: Suzanne.Higgins@afbini.gov.uk or info@afbini.gov.uk
Telephone +44 (0)28 90 255 636

New Phosphate Management Protocols to Maximise Grass Production

Key Messages

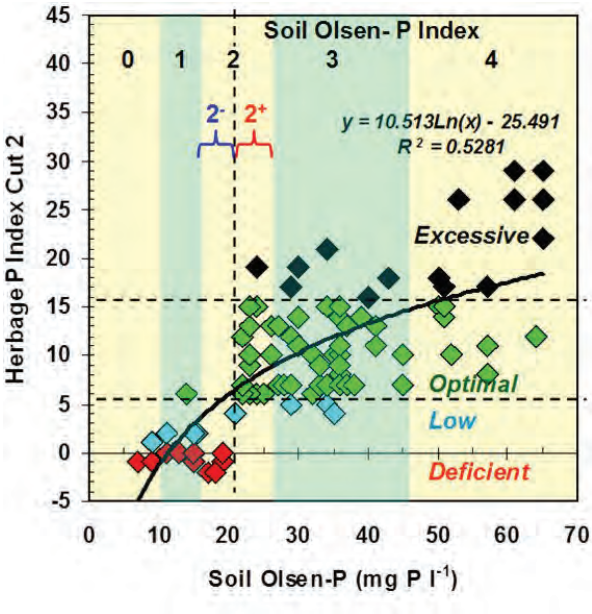
- A soil test will indicate the requirement for phosphate fertiliser
- Previous guidelines recommended a soil P Index of Index 2 (16 – 25 mg/l Olsen P) to maintain soil reserves and meet crop requirements
- Research by AFBI has identified the need for a new target P range for both cut and grazed grassland of 21 – 25 mg/l Olsen P (Index 2+) to optimise sward productivity

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 P 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.

AFBI research confirms the need for new P_2O_5 recommendations

Monitoring of soil and sward P levels 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 P deficient when 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 1). 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. 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 recommended 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 P_2O_5 recommendation for silage crops on Index 1 soils and the remainder is supplied as chemical fertiliser, only 63% (30 kg P_2O_5/ha) of the recommended crop-available P2O5 input (48 kg 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 = 48 kg P_2O_5/ha
- 66 m3/ha cattle slurry supplies 36 kg total P_2O_5/ha or 18 kg available P_2O_5/ha
- Amount of chemical P_2O_5 permitted is thus 48 - 36 kg P_2O_5/ha = 12 kg P_2O_5/ha
- Total available P_2O_5 applied is therefore only 12 + 18 kg P2O5/ha = 30 kg P_2O_5/ha

A case was therefore made by AFBI 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. The case was accepted and the Phosphorus Regulations (2015) were revised accordingly. So in the case above, chemical P_2O_5 at 30 kg/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.

For further information on P fertilizer at grass contact:
John Bailey: John.Bailey@afbini.gov.uk or info@afbini.gov.uk
Telephone +44 (0)28 90 255 636

Maximising The Value Of Grass

Debbie McConnell

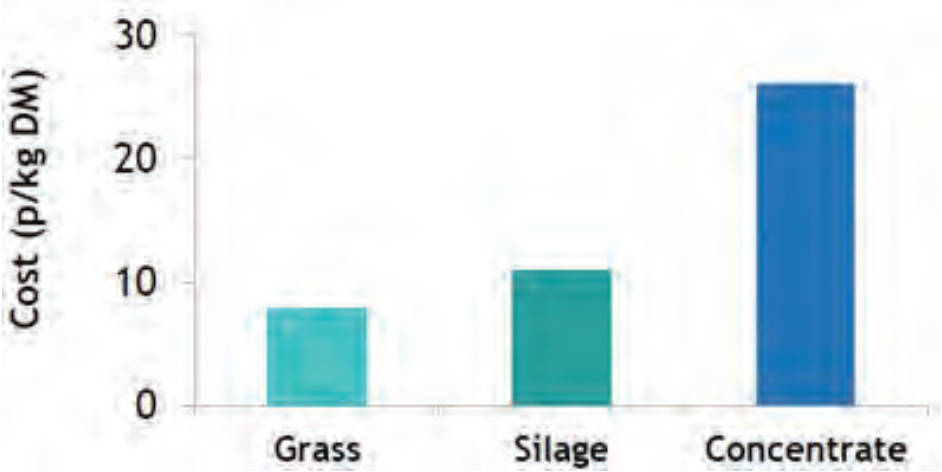
Key messages

- Grass remains the cheapest feedstuff available to Northern Ireland dairy farmers and there is considerable potential to increase both grass growth and utilisation to improve milk production from forage.
- Each additional 1000 litre increase in milk from forage is associated with a £10 798 improvement in net profit on a 100 cow dairy farm.
- Regardless of system, on-farm data shows it is possible to achieve over 12t DM/ha/yr of grass production on dairy farms in Northern Ireland.
- Achieving target pre grazing grass yields of 3000-3300kg DM/ha and post grazing residual yields of 1600-1800 kg DM/ha is essential to maintaining high levels of grass quality and utilisation throughout the season whilst maintaining animal performance.
- Reviewing average farm covers and the GrassCheck growth forecasts regularly will help manage grass surpluses and deficits throughout the grazing season.
- Extending the grazing period in the autumn is worth over £1000/week on a 100 cow dairy farm however good infrastructure and sward management is essential to maximise returns.

The value of grass

Grazed grass remaining the cheapest form of feedstuff for NI dairy herds (6p/kg DM) when compared with grass silage (10p/kg DM) and concentrates (25p/kg DM) (Figure 1). However in recent years there has been a declining trend in the use of grass on N.I. dairy farms, with CAFRE benchmarking data highlighting a 24% reduction in the volume of milk produced from forage between 2001 and 2016, falling from 3206 to 2429 litres per cow per year, respectively. During the same time frame, concentrate feed rate increased by 0.10kg per litre.

Figure 1 Comparison of costs between different feedstuffs available to NI dairy farmers.



There is a clear financial benefit to reversing this trend. An analysis of seventeen years of CAFRE benchmarking data over the period 2000 to 2016 inclusive, indicates that the top 25% of farms ranked on milk from forage have been 3.4ppl (or £241/cow) more profitable than the bottom 25% of farms (Table 1). For each additional 1000 litre increase in milk from forage this was equivalent to a £10 798 difference in net profit on a 100 cow dairy farm

Table 1: Difference in cow performance and net margin on the bottom and top 25% of CAFRE benchmarked farms ranked on milk from forage throughout the time period 2000 - 2016.

	Bottom 25%	Top 25%	Difference
Yield per cow (litres)	6893	6943	50
Concentrate fed (kg/cow)	2675	1597	-1078
Milk from forage per cow (litres)	949	3394	2445
Net profit (£/cow)	292	556	264

With increasing volatility in the cost of purchased feedstuffs, it is important that we aim to maximise the proportion of grazed or ensiled grass in dairy cow diets. This paper focuses on how dairy farms can improve grazed grass utilisation to maximise milk output from forage and reduce farm costs.

Current grassland performance

Currently the average dairy farm in N.I. is estimated to grow and utilise an average of 7.5 tonnes of dry matter per hectare (t DM/ha). This figure equates to 50% of the yield achievable by modern day grass varieties and suggests a lost opportunity to reduce feed costs and consequently 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.

During 2017, AFBI's GrassCheck project (www.agrisearch.org/GrassCheck) has been monitoring grass growth and quality on 12 commercial dairy farms (and 18 beef farms), (Figure 2). These dairy farms span a range of land types (from severely disadvantaged areas to prime lowland), milk output (5000 - 9000 litres/cow) and calving system. Weekly grass growth data is recorded across the grazing platform by the farmers. All farms have displayed high levels of grass growth through the first four months of the grazing season, growing an average of 9.6t DM/ha between March and July (Table 2). Using expected growth rates for late summer/autumn, these farms are on target to achieve over 12t DM/ha this season.

Figure 2: Location of the 2017 GrassCheck plots (yellow), dairy farms (blue) and beef farms (red).

Table 2: Average daily grass growth rate and total yield of grass grown on grazing paddocks on 12 commercial dairy farms during the period March – July 2017

Farm Number	Calving pattern	Average growth rate (kg DM/ha)	Grass yield (t DM/ha)
1	Autumn/Spring*	77.7	11.4
2	Winter	55.5	8.9
3	Winter	56.3	9.0
4	Spring	49.7	8.0
5	Spring	69.3	11.2
6	Winter	59.6	9.6
7	Autumn	60.9	9.8
8	Autumn/Spring	55.3	8.9
9	Winter	52.7	8.5
10	Autumn/Spring	56.2	9.0
11	Spring	55.8	9.0
12	All year round*	74.3	11.4

*zero-grazing farm

Across the farms, grass quality has also averaged 17.9% dry matter, 18.6% crude protein and a metabolisable energy content of 11.6MJ/kg DM. Grasscheck 2017 has clearly demonstrated the potential to achieve high levels of good quality grass production across a range of management systems and locations.

Managing the grazing sward

Studies at AFBI Hillsborough using high yielding dairy cows, have demonstrated that, when offered as the sole feed, grazed grass can sustain daily milk yields of up to 27 kg per cow in late May, with this value declining to 14 kg per cow by late September (Figure 3). However, to achieve high levels of milk production from grazed grass it is important to ensure a consistent supply of high quality pasture. This can prove challenging given within-seasonal variability in weather conditions, nutrient availability, grass growth and the influence of reproductive grass tillers (heading).

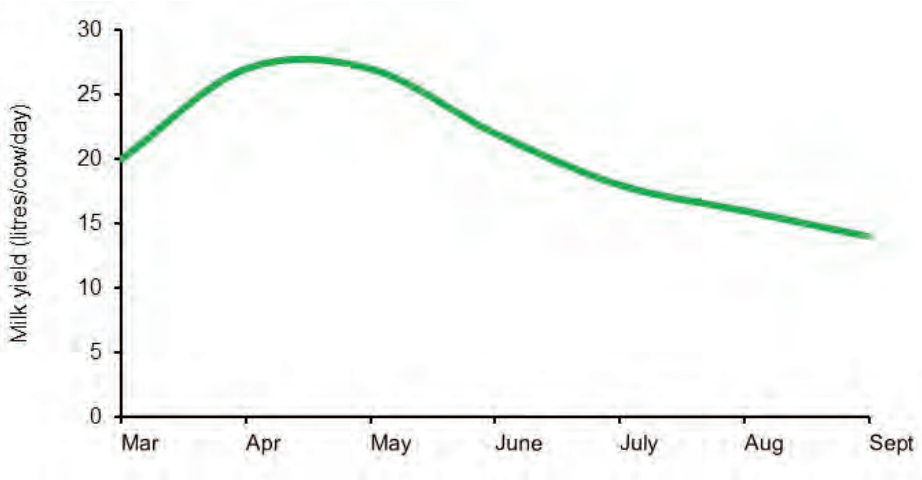


Figure 3: Seasonal milk yield profile when using grazed grass as the sole feed.

The most important technique to maintain a consistent supply of high quality grass throughout the season is to ensure swards are grazed at the correct stage to achieve the optimum balance of yield and quality. Grazing grass at the optimum growth stage will result in:

- Higher intakes of good quality pasture
- Increased milk yields
- Reduction in herbage wastage
- Higher quality re-growths
- Shorter re-growth intervals
- Improved response to nitrogen fertiliser

Efficient grazing systems graze the plant at the point of most rapid growth whilst still retaining a high leaf: stem ratio. Identifying this point can be achieved by measuring herbage mass either using a platemeter or quadrant clip. It is also possible to make this estimate by counting the number of leaves on the plant however studies have shown this to be less accurate than determination of actual herbage mass through measurement with equipment such as a platemeter.

In N.I., dairy farms should target pre-grazing grass covers of 3000-3300 kg DM/ha and post-grazing covers of 1600 – 1800 kg DM/ha. Research conducted at AFBI has shown that although reducing pre- and post-grazing targets below

these levels will improve pasture utilisation, it is also likely to result in a reduction in milk yields. This is particularly evident with high yielding cows. In a recent study conducted at AFBI with cows yielding 36 litres at the beginning of the study, implementation of a 'tight' post-grazing residual of 5.2cm resulted in a 1.8 litre/day reduction in cow performance relative to a 'normal' post grazing residual of 6.1cm. Hence achieving a post-grazing sward height of 1600 – 1800kg DM/ha is a reasonable compromise between sward utilisation and animal performance.

If considering plant leaf counts, swards should be grazed when the third leaf is fully emerged but before the first leaf begins to die (Figure 4). Grazing swards too early (<2.5 leaves) will result in a loss of yield and repeated early grazing can impact on sward persistency. In contrast, grazing swards too late will cause a build-up of stem at the base of the sward reducing overall sward quality and performance.

Table 3: Targets for pre- and post-grazing grass covers for N.I. dairy farms

Targets	Kg DM/ha
Pre-grazing herbage mass	3000 - 3300
Post-grazing herbage mass	1600 – 1800
Average farm cover	2400

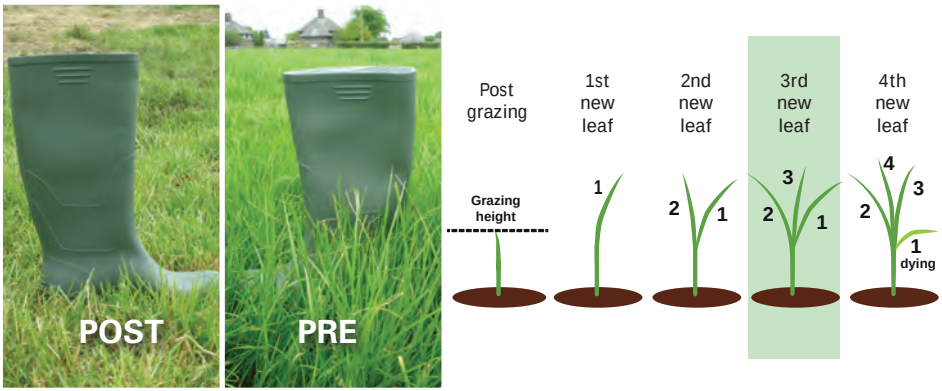


Figure 4. Optimum pre- and post- grazing grass covers for NI dairy farms and target leaf stage for grazing.

Undertaking regular measurement of pre- and post-grazing residuals is essential to achieving good grass utilisation. Regular measurement of pasture will also assist in identifying surpluses and deficits of grass which will appear throughout the season. Paddocks with grass covers in excess of 3300kg DM/ha should be taken out of the grazing rotation for silage. Similarly if post-grazing residuals are above the target, re-grazing or mowing are an option to maintain sward quality in the next rotation.

Managing grass availability throughout the season at field and farm level.

Managing grass availability across the grazing platform and throughout the grazing season can be challenging given the weekly variability in grass growth rates. However, understanding and forecasting expected grass growth rates throughout the season is a valuable tool in making management decisions.

Since 1999, AFBI's GrassCheck project has been monitoring grass growth and quality throughout the growing season across two sites, AFBI Hillsborough and CAFRE, Greenmount. Data are generated from four sets of monitored plots, managed under a simulated grazing regime and receiving 270kg N/ha.

Through each season, growth rates across both sites average 50kg DM/ha/day. However this varies considerably each week particularly in late Spring/early summer when periods of rapid growth typically occur. For example during May 2016, growth rates accelerated from 37.5kg DM/ha/d to 115kg DM/ha/d over a three week period, before proceeding to vary by up to 40kg DM/ha/d each week for the next month.

To assist farmers in dealing with this variation, seven and fourteen day grass growth forecasts are produced and published on a weekly basis using a 'grass growth rate model' developed by AFBI in 2005. The model predicts daily grass growth rate depending on weather conditions and management decisions such as nitrogen input. Using these growth rate predictions, farmers can identify potential surpluses or deficits in grass supply throughout the season.

During 2017, each of the GrassCheck monitor farms were fitted with an automatic weather station, recording key meteorological parameters such as rainfall, solar radiation and soil temperature. On-going work is taking place to refine the GrassCheck model and examine its potential to predict grass growth on individual farms across N.I.

Average farm cover is also a useful measure of future grass availability. A target average farm cover of 2400kg DM/ha should be sought throughout the growing season as this ensures an adequate supply of grass for the coming rotation. In situations where average farm cover significantly exceeds 2400kg DM/ha there is the potential to close out high cover swards for a longer time period. In contrast when average farm cover falls considerably below target, increasing the area in the grazing rotation or introducing a buffer feed will be required.

Supplementing cows at pasture

The milk-yield potential of the majority of N.I. dairy herds has increased considerably during the last few decades, and consequently grazed grass as the sole feed is frequently unable to meet the energy requirements of these higher-yielding cows during the grazing season. Whilst it is imperative that we aim to maximise the use of grazed grass in the diet throughout the season, there remains a gap between the maximum milk yield that can be supported by grazed grass alone and the actual milk yield of higher-yield dairy cows. Hence concentrate supplementation is required to avoid excessive body-tissue losses and maximise output from the dairy herd.

To ensure that concentrates are used efficiently it is important that an economic milk yield response is achieved when concentrates are offered and the optimum feed rate allocated. A recent study at AFBI examined the effect of adopting three different concentrate feed rates (0.25, 0.45 and 0.65 kg of concentrate per litre of milk), on the performance of grazing dairy cows on a feed to yield basis. Concentrates were offered to individual cows to support milk yields above set Maintenance-Plus values, which were revised at fortnightly intervals throughout the grazing season.

Although total dry matter intakes were highest for cows on the highest concentrate feed rate treatment (0.65 kg of concentrate per litre of milk), these cows had the lowest grass intake due to 'substitution' of grass by concentrates in the diet.

Increasing concentrate feed rate from 0.25 to 0.45 kg/litre of milk resulted in a 2.5 kg/cow/day increase in milk yield (Table 4). However, a further increase in concentrate feed rate to 0.65 kg/litre of milk resulted in only a small (and not statistically significant) increase in milk yield. In addition, margin-over-concentrates was highest at a concentrate feed rate of 0.45 kg concentrate/

litre and, when margins were examined under a wide range of milk price (22 to 35 pence per litre) and concentrate cost (£200 to £300 per tonne) scenarios, margins remained highest with the 0.45 kg feed rate treatment.

Table 4: Cow performance on different concentrate feeding rates

	Concentrate feed rate (kg per litre of milk produced above the Maintenance-Plus value)		
	0.25	**0.45**	**0.65**
Concentrate DMI (kg/cow/day)	1.7	3.2	4.9
Grass dry matter intake (kg/cow/day)	11.9	12.3	10.9
Total dry matter intake (kg/cow/day)	13.6	15.5	15.9
Milk yield (kg/cow/day)	19.0	22.0	22.4
Milk fat-plus-protein yield (kg/cow/day)	1.27	1.43	1.48
Margin over concentrates (£/cow/day)	4.07	4.88	4.50

Maximising returns from autumn grass

In 2016, exceptional grass growing conditions were evident in September and October with growth rates averaging 42.9 kg DM/ha/day recorded through the GrassCheck project. This resulted in a total growth of 2566 kg DM/ha and provided an excellent opportunity to reduce feed and housing costs by extending the grazing season. GrassCheck grass quality results suggest that although grass dry matter contents fall throughout the course of the season, well managed swards can produce metabolisable energy contents over 11.5 MJ/kg DM during the autumn period, providing a valuable source of feed for dairy cows.

Previous AFBI research has shown that autumn grass has a key role to play in the diet of both spring and autumn calving cows. For both groups, giving access to pasture during the period 29 October to 26 November was found to increase milk yields by over two litres/cow/day compared with cows fed ad-lib silage (Table 5).

Table 5: Effect of grass inclusion in the diet of spring and autumn calving cows during autumn grazing

	Spring calving cows		Autumn calving cows	
	Ad-lib silage +2kg DM concentrate		Ad-lib silage +6kg DM concentrate	
	Grazing	No-grazing	Grazing	No-grazing
Grass DM intake (kg DM/cow/day)	4.2	0	4.5	0
Silage DM intake (kg DM/cow/day)	6.8	10.7	6.8	11.0
Milk yield (litres/cow/day)	14.6	12.3	25.2	23.1
Fat (%)	4.57	4.18	4.00	4.12
Protein (%)	3.46	3.22	3.37	3.14

This milk yield response coupled with reductions in slurry spreading requirements, savings in bedding materials and labour, and lower feed costs resulted in savings of £1.55 per cow per day. For a 100 cow dairy farm, this equates to £1085 additional profit for every week cows remain at grass during the autumn period.

However achieving a high utilisation of grass in late autumn, and also early spring, can be challenging with higher soil moisture levels typically evident. This can in part be combatted by:

- Ensuring a good infrastructure of tracks and gateways to the grazing area
- Allocating grass with front and back fences daily
- Using short and flexible grazing periods (1.5 – 5 hours per day)

Setting up for Spring 2018

Similar reductions in feed and housing costs can be achieved from early turnout in Spring. As a result it is important to balance autumn grazing with spring grass requirements to ensure adequate covers are available. This is particularly important for spring block calving herds. To ensure that this is achieved, it is important to start to plan for the next grazing season in early autumn. The following aspects should be considered:

- Graze paddocks to the target residual to encourage winter tillering of the grass plant.
- Avoid re-grazing fields that have been closed
- Aim to close the driest fields first, to allow access to these first in spring
- Avoiding building heavy covers for autumn grazing as these will be difficult to graze in wet conditions and have a knock on impact on spring grass quality.

Conclusions

There is considerable scope to improve milk production from forage on N.I. dairy farms and increase financial returns significantly. This can be achieved through improvements in grassland production and utilisation rates. On-farm monitoring suggests that annual yields of over 12t DM/ha can be achieved on grazing paddocks however achieving target pre- and post-grazing residuals of 3000 - 3300kg DM/ha and 1600 - 1800kg DM/ha respectively is essential to maintaining high levels of grass quality and utilisation throughout the season whilst maintaining animal performance.

Acknowledgements

The studies mentioned in this section were funded by the Department of Agriculture, Environment and Rural Affairs and AgriSearch.

For further information on GrassCheck and on increasing milk production from forage, contact Debbie McConnell at AFBI via email at debbie.mcconnell@afbini.gov.uk or telephone 02892 682484.

Improving Efficiency Within Winter Feeding Systems

Conrad Ferris

Key Messages:

- Thin cows (body condition score of less than 2.25 at calving) have an increased risk of being culled post calving.
- It is difficult to improve the body condition score of thin cows during late lactation or during the dry period. It is therefore necessary to monitor the body condition score of the herd throughout the lactation, and especially during the last third of lactation, and aim to dry-off cows at a body condition score of 2.75.
- When cows with a condition score of 2.5 or above at drying-off are offered good quality silage together with a quality dry cow mineral supplement, there are unlikely to be milk yield, health or fertility benefits as a result of offering concentrates during the dry period.
- Concentrate levels should be increased gradually over the first three weeks post calving to optimise forage intakes and reduce the risk of rumen problems.
- Very similar levels of performance can be achieved with different concentrate feeding systems, provided these are managed correctly.
- The milk fat content of cows offered high concentrate levels within feed-to-yield systems is likely to be reduced, thus reducing the value of each litre of milk produced. As a consequence, higher yielding cows will have a reduced margin-over-feed costs when high concentrate feed rates are used.
- Feed-to-yield systems should take account of the milk composition of individual cows, as well as individual cow milk yields.
- The availability of high quality silage this winter offers real opportunities to reduce concentrate feed levels and significantly improve profit margins.

If Northern Ireland dairy farms are to remain competitive, a continued and relentless focus on improving all aspects of production efficiency is required. Given that concentrates comprise 60-70% of variable costs on local dairy

farms, and that a large proportion of concentrates are offered during the winter months, management decisions during the Winter can have a significant impact on overall farm profitability.

In recent years a number of AFBI studies have examined strategies to improve performance within winter systems. Issues examined have included management strategies for thin cows in late lactation, the impact of concentrate feeding on dry cow performance, and the impact of early lactation concentrate feeding strategies and concentrate feed rates. However, in order to harness the benefits of this research, the first requirement is to know the quality of the silage available on your farm.

While the quality of the silage in your pit can not be changed at this stage, knowing its feed value is essential. Given the excellent spell of weather in May and June this year, many farmers will have access to high quality silage this winter, and this can offer real opportunities to reduce feed costs provided the quality of the silage is known. If you have not already done so, then take the first step in feed planning this winter by having a representative sample of each silage pit analysed. With larger silos, have the silage analysed on a number of occasions throughout the winter as composition can change as you feed through the pit. Contact the Hillsborough Feed and Information Service (HFIS) based in AFBI Hillsborough for details of how to have your silage analysed (028 9268 1583 or 1589 or 1580; or email: forage.analysis@afbini.gov.uk)

The following articles provide information on the outcomes and implications of a number of recent studies into winter feeding strategies, which have been conducted by the AFBI Hillsborough dairy research team.

Management of dairy cows during late lactation and the dry period

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 (less than 2.5). These low body condition score cows have an increased risk of health and fertility problems following calving, and an increased risk of being culled. A recent study examined a number of strategies to improve the body condition score of thin cows (cows with a body condition score of 2.25 at 14 weeks pre-calving), as follows:

1. *Normal protein:* Grass silage plus 5.0 kg/day of a 'normal protein' concentrate (20.6% crude protein, 18.2% starch; fresh basis) from 13 weeks pre-calving until 8 weeks pre-calving. These cows were then dried-off and offered grass silage without concentrates until calving.

2. *Low protein:* Grass silage plus 5.0 kg/day of a 'low protein/high starch' concentrate (13.4% crude protein, 25.8% starch; fresh basis) from 13 weeks pre-calving until 8 weeks pre-calving. 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.

Cows offered the Low protein diet in late lactation produced less milk (1.2 kg/day less milk) than those offered the Normal protein diet, but they also had a lower intake at this time, and there was no benefit in body condition score (Table 1). Following drying-off, cows on the Normal and Low protein diets 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. 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. Based on these results the use of low protein/high starch concentrates in late lactation cannot be recommended as a management practice to improve body condition.

Adopting an 'Extended dry period' reduced full lactation milk production by approximately 350 kg, although cows on this treatment were also offered 175 kg 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 during the subsequent lactation, or compensate for the loss of production in the current lactation.

Table 1 Effect of dietary 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

Having examined the late lactation period, it is also important to consider the dry period. Nutrition during the dry period should aim to prepare the dairy cow for the increase in milk production in early lactation, whilst minimising the risk of metabolic problems and infectious diseases post calving.

The optimum body condition score for cows at drying-off is often the subject of much debate. In a recent on-farm study involving over 1200 cows, cows with a Moderate/High condition score at the time of drying off lost more body condition during the dry period and during the first 12 weeks following calving than cows with a Low condition score at drying off (Figure 1). However, fat + protein yield was unaffected by condition score at drying off, while fertility tended to be marginally improved with the lower body condition score cows. Nevertheless, the study highlighted that thin cows (condition score of 2.25

or less) had a higher risk of being culled during the first 60 days post calving. Thus for cows managed on high input systems, these results support the recommendation of a target condition score at drying off of no greater than 2.75.

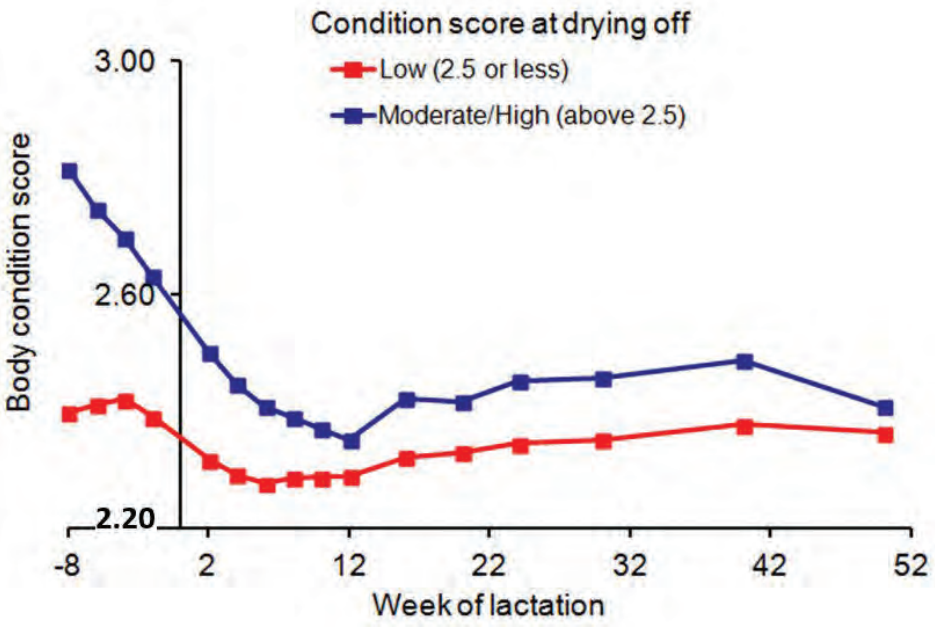


Figure 1 The effect of condition score at drying off on condition score change during the dry period and subsequent lactation

However, many cows have a body condition score of less than 2.75 at drying off and these cows may need to be managed to achieve the correct condition score at calving. To address this, a number of studies have examined the impact of offering concentrates during the dry period to cows with a low condition score at drying off (approximately 2.25). One of these studies involved a comparison of three treatments, as follows:

1. *No concentrates:* Forage only during the dry period.
2. *Final three weeks:* Forage plus 3 kg concentrates/day during the final three weeks of the dry period.
3. *Entire dry period:* Forage plus 3 kg concentrates/day during the entire dry period,

Concentrate feeding during the dry period had no effect on body condition score change during either the dry period or in early lactation (Figure 2), or on milk yield or milk composition (Table 2). In addition, concentrate feeding during the dry period had no effect on either calf birth-weight, fertility performance or cow health during the subsequent lactation. Thus with good quality silage offered ad lib, 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 is in agreement with the outcomes of two further studies undertaken at AFBI.

These findings highlight an important management strategy, namely that cows should be dried off at the target condition score for calving. Given the difficulties already discussed in managing thin cows to gain body condition in late lactation, it is important that body condition score is monitored throughout the lactation, and especially from mid lactation onwards. While concentrate feeding during the dry period had little effect on subsequent cow performance within these AFBI studies, concentrates can provide a useful carrier for dry cow minerals, and there is considerable evidence that feeding a quality dry cow mineral is a key component of a successful dry cow management programme.

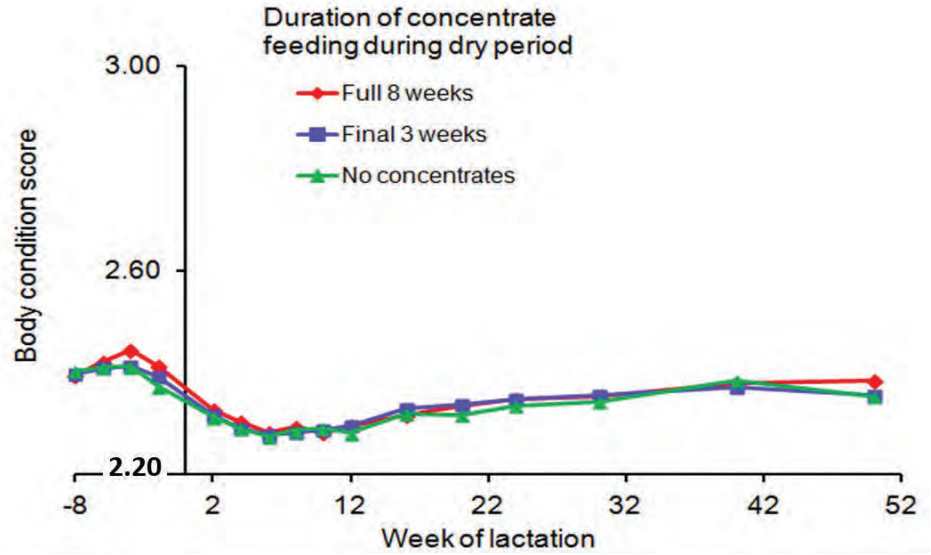


Figure 2 The effect of offering concentrates to thin cows during the dry period on condition score change during the dry period and subsequent lactation.

Table 2 Effect of offering concentrate to thin cows during the dry period on average milk production during the first 10 months post calving

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

Early lactation concentrate build-up strategies and concentrate allocation strategies

As the milk yield potential of the Northern Ireland dairy herd has increased, concentrate feed levels have also increased in an attempt to meet the higher nutrient requirements of these cows. However, higher milk yields in early lactation, combined with higher concentrate feed levels, may increase negative energy balance, metabolic stress and the risk of digestive upsets. A number of studies were conducted to examine if some of these issues could be overcome by introducing concentrates into the diet of fresh calved cows at a slower rate.

One of these studies involved a comparison of a Rapid, Intermediate or Slow concentrate build-up strategy in early lactation. From calving onwards all cows were offered a 'basal' ration comprising good quality grass silage plus 6.0 kg of concentrate/day. A second concentrate was then introduced into the diet from calving onwards using either a Rapid (0.8 kg/cow/day), Intermediate (0.31 kg/cow/day) or Slow (0.19 kg/cow/day) concentrate build-up strategy. Cows on each of these treatments were receiving their full concentrate allowance (8.0 kg/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 3). 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. Two further studies were conducted to examine the impact of a delayed concentrate build up strategy, with one of these conducted on five commercial dairy farms. Based on the results of these three studies, 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

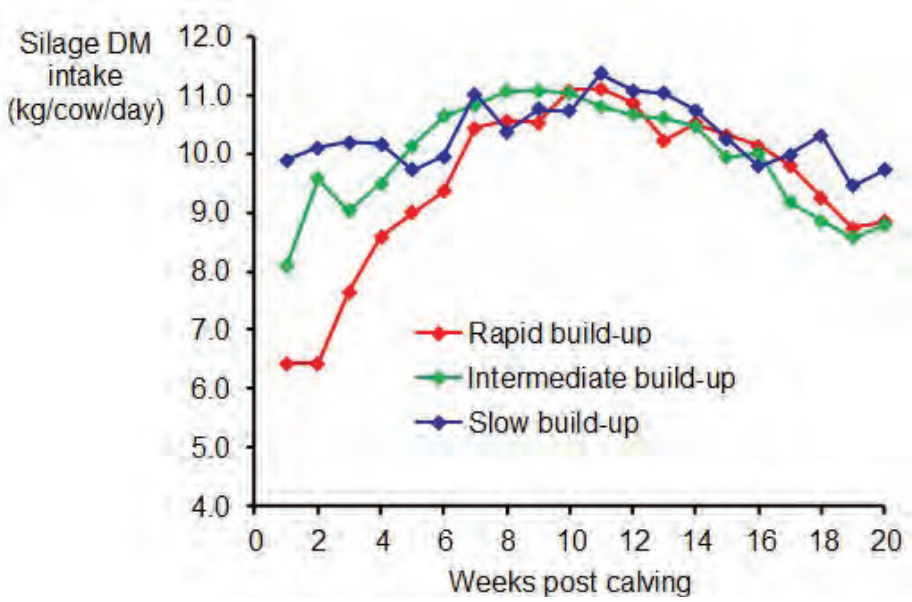


Table 3 The effect of concentrate build-up strategy on daily milk yields and milk composition over the first 150 days of lactation

	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)	3.16	3.08	3.00

While building-up concentrates at a moderate rate over the first three weeks of lactation is advised, there is still debate as to the optimum concentrate allocation strategy thereafter. Indeed, a number of concentrate feeding systems and allocation strategies are adopted on local dairy farms, it is unclear if all of these are equally effective. To address this, a number of studies were conducted to examine the impact of concentrate feeding and allocation strategies on cow performance. In one of these studies concentrates were offered using two different approaches, as follows:

1. *Total-mixed-ration:* with this treatment, the grass silage and concentrates (50% silage : 50% concentrate, on a dry matter basis) were mixed using a complete diet mixer wagon.

2. *Feed-to-yield:* with this treatment, the grass silage and concentrates were offered separately. Concentrates were offered 'Feed-to-yield', with the grass silage calculated to sustain an average milk yield of 24 kg per cow per day, and with concentrates then offered to sustain milk yields above this level of performance (at a feed rate of 0.45 kg concentrate per kg of milk).

Total concentrate intakes were very similar with each of the two treatments. However, cows on the Total-mixed-ration treatment had a relatively 'flat' concentrate intake curve, while the concentrate intake curve for cows on the Feed-to-yield treatment (Figure 4) followed the shape of the milk yield curve.

Cows offered the Total-mixed-ration produced 1.3 kg per day more milk than cows on the Feed-to-yield strategy (Table 4), although this difference was not statistically significant. In addition, cows offered the Total-mixed-ration had a 'flatter' more persistent lactation curve than those on the Feed-to-yield' strategy (Figure 5). Nevertheless, neither milk fat nor milk protein content was affected by concentrate allocation strategy. There were however a greater number of cows with rumen problems (right and left displaced abomasum and dilated caecum) under the Feed-to-yield strategy, with this likely due to the large quantity of concentrates offered to some cows on this treatment.

This study demonstrates that similar levels of milk production can be achieved with a simple 'group' feeding system involving a total-mixed-ration, as with a more complex system involving allocating concentrates to individual cows. However, it is important to note that this study involved a group of cows with a tight calving pattern (October to December calving), and consequently all cows were at a relatively similar stage of lactation throughout the study period. In contrast, herds on most farms have a much wider spread in calving pattern, with freshly calved cows frequently mixed with cows in mid and late lactation. In this scenario, offering a single Total-mixed-ration would result in late lactation cows being over-fed, and concentrates being used inefficiently. When a Total-mixed-ration is offered to herds with a more widely spread calving pattern, cows need to be grouped according to milk yield to avoid either overfeeding or underfeeding. The adoption of a 'Feed-to-yield' approach would clearly overcome this problem. Nevertheless, irrespective of which strategy is adopted, 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.

Table 4 Effects of concentrate allocation strategy on milk production and the incidence of rumen health problems

	Concentrate allocation strategy	
	Feed-to-yield	Total-mixed-ration
Milk yield (kg/day)	38.0	39.3
Milk fat (%)	4.29	4.31
Milk protein (%)	3.30	3.25
Cows with rumen problems (%)	22	8

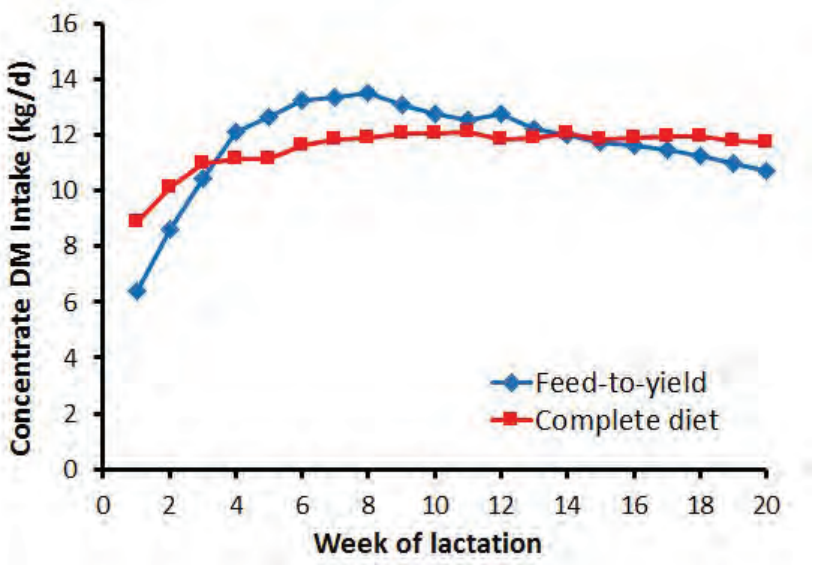


Figure 4 Effect of concentrate allocation strategy on average daily concentrate DM intake

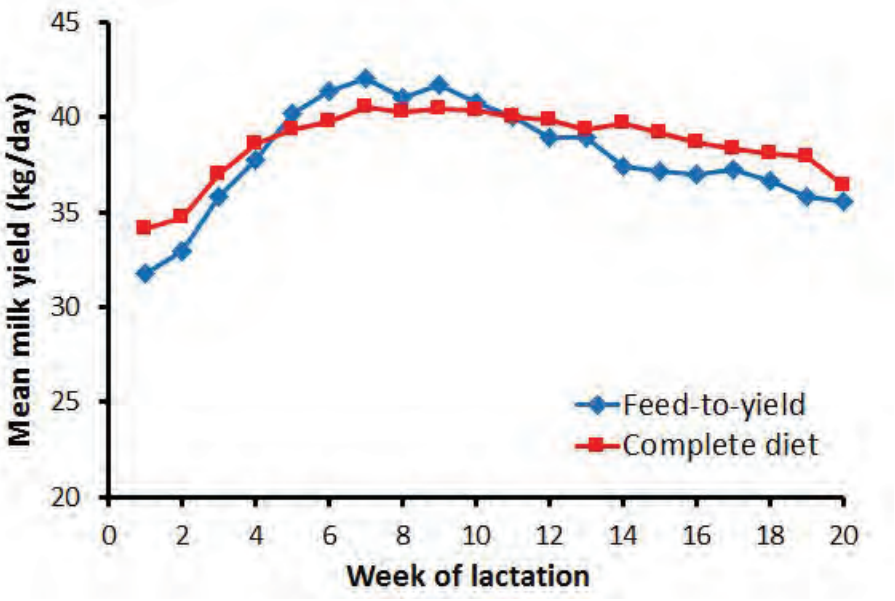


Figure 5 Effect of concentrate allocation strategy on average daily milk yield

The impact of concentrate feed rate on cow performance

While overfeeding of concentrates is something that no farmer can afford to do, there is evidence that overfeeding takes place on some farms. In these scenarios, the milk-yield response to concentrates offered is often poor and uneconomic, and in many cases a proportion of the concentrate offered could be replaced by lower-cost silage.

Within Northern Ireland many herds are now fed on a 'feed-to-yield' basis, with additional concentrates offered at a fixed 'feed rate' for each litre of milk produced above the performance that can be supported by a basal diet. The feed-rate that is most often used is 0.45 kg of concentrate per litre of milk, although this is very much a theoretical value. Consequently a study was conducted to examine the impact of adopting a range of concentrate feed rates on cow performance, and to improve our understanding of dietary substitution within feed-to-yield systems.

Following calving, cows were given ad libitum access to a 'basal' mixed ration designed to meet the maintenance-energy requirements of the cows. In addition, cows were also offered concentrates at one of four feed rates, namely 0.35, 0.45, or 0.55 kg of concentrates for each kg of milk produced above the maintenance-plus yields. The amount of concentrate offered to each individual cow was determined weekly based on her average daily milk yield during the previous seven days.

As the concentrate feed rate increased, there was a general decrease in silage DM intakes (Table 5). However, increasing concentrate feed rate from 0.35 to 0.45 kg had no effect on concentrate DM intake, suggesting that a feed rate within this range will have relatively little impact on total concentrate intakes when supplementing a basal diet. Considering these results, the finding that increasing the feed rate from 0.35 to 0.45 kg had no effect on milk yield was as expected. However, concentrate intakes increased substantially at the 0.55 kg feed rate, and there was a small numerical increase in milk yield. This was accompanied by a reduction in milk fat content at the 0.55 kg feed rate due to the higher concentrate intakes. The overall effect was that neither milk fat-plus-protein yield nor milk value differed between any of the feed-rate treatments.

The current study allows us to examine the effect of increasing milk yield on silage DM intake (Figure 6). With the 0.35 kg feed rate treatment, silage DM intake did not change across a wide range of milk yields. However, with the 0.45 kg feed rate treatment, silage DM intake decreased by 0.8 kg with each 10 kg increase in milk yield. With the 0.55 kg feed rate treatment, silage DM intake decreased by approximately 1.2 kg with each 10 kg increase in milk yield. The observed reductions in silage intake with increasing milk yields were smaller than expected, based on 'normal substitution rates'. This is due to the fact that within a feed-to-yield system it is the higher yielding cows that are offered more concentrates, and these cows normally have a greater intake capacity. These cows have the potential to maintain forage intakes despite their increasing concentrates intakes.

Table 5. Effect of concentrate feed rate on feed intakes and cow performance

	Concentrate feed rate		
	0.35	0.45	0.55
Silage DM intake (kg/day)	11.6	10.9	10.2
Concentrate DM intake (kg/day)	10.0	10.8	12.9
Total DM intake (kg/day)	21.5	21.7	23.1
Milk yield (kg/cow)	36.9	36.3	38.1
Milk fat (%)	4.06	4.09	3.81
Milk protein (%)	3.25	3.33	3.25
Milk fat-plus-protein yield (kg per cow per day)	2.65	2.68	2.68
End-of-study body condition score	2.40	2.46	2.47

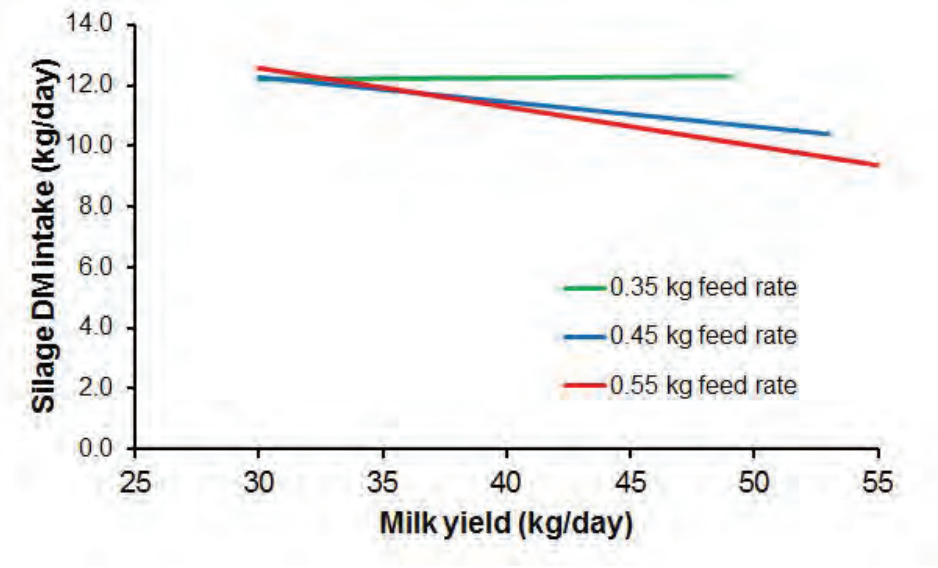


Figure 6 Effect of increasing milk yield on silage DM intake with the three feed rate treatments

The effect of concentrate feed rate on margin-over-feed costs (£ per cow per day) was also examined at milk prices of 18, 26 and 34 pence per litre (Figure 7). 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). This study highlights the need to be cautious when adopting feed rates in excess of 0.45 kg per litre in feed-to-yield systems, and suggests that levels of concentrate offered should be based on a 'corrected milk volume' that takes account of milk composition.

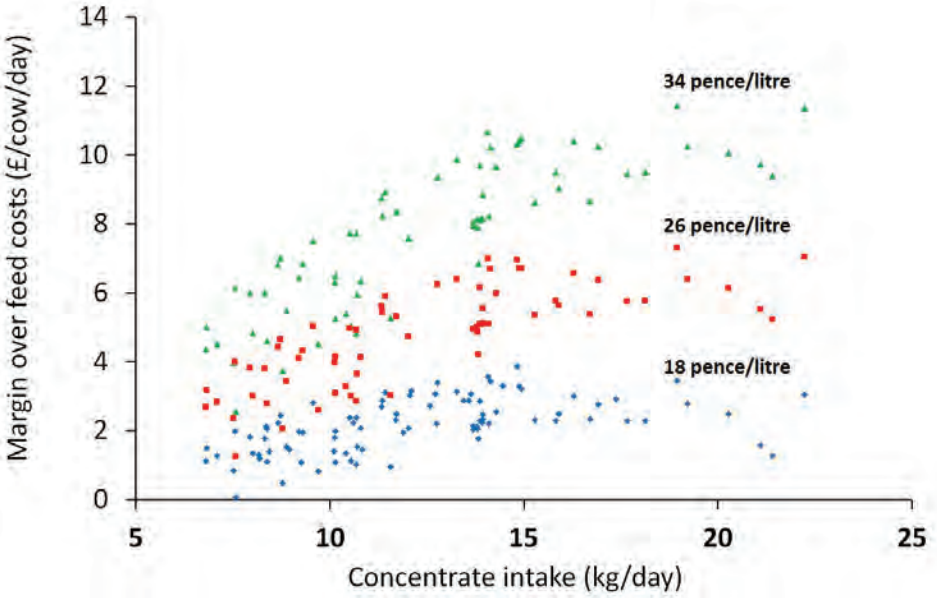


Figure 7: Relationship between concentrate intake and margin-over-feed costs for each individual cow (data combined for the three feed rate treatments, and presented at three different milk prices)

Maximising the contribution of high quality silage this winter

Data from the Hillsborough Feeding Information System (HFIS) highlights that in general, first cut silages this year have higher dry matter (DM) contents (average, 33.5% DM) and higher Metabolisable Energy (ME) contents (average, 11.2 MJ/kg DM) than silages made during either 2015 or 2016. The availability of this higher quality silage offers a real opportunity to reduce feed costs this winter. To examine this further, concentrate levels required to achieve four 'target' milk yields (25, 30 or 35 litres of milk/day) were determined for three silages of different qualities. The qualities of the silages were described as 'poor', 'average' and 'high', and these had average ME concentrations of 10.2, 11.2, and 12.2 MJ/kg DM, respectively, and average FIM intake values of 70, 84 and 105 g/kg LWT0.75, respectively. The 'average' quality silage in this analysis represents the average quality of first cut silages made during 2017. The concentrate feed levels were calculated for an early lactation cow (second lactation) of average genetic merit (585 kg live-weight, body condition score of 2.5), and losing 0.5 kg live-weight/day. The outcomes are summarised in Table 6.

Table 6. Effect of silage quality ('low', 'medium' or 'high') on concentrate levels required to achieve target milk yields of 25, 30 or 35 litres/cow/day

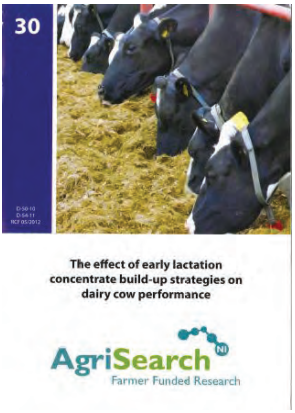
	Target milk yields (litres/day)		
	25	30	35
Low quality silage (ME = 10.1)	8.3	12.3	16.3
Medium quality silage (ME = 11.2)	6.1	10.7	15.3
High quality silage (ME = 12.2)	2.0	7.6	13.2

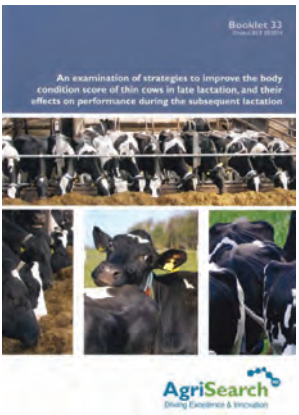
The data in Table 6 clearly demonstrates the impact that silage quality can have on concentrate requirements. For example, to achieve a target milk yield of 30 litres per day, 12.4 kg concentrate is required when a low quality silage is available, compared to 8.7 kg concentrate with a high quality silage, a saving of 3.7 kg concentrate/day. This clearly highlights the need to know the quality of your silage, and to take this into account when making feeding decisions.

While values presented in Table 6 highlight the expected performance across a range of concentrate levels, it must be considered if it makes economic sense to adopt high levels of concentrate feeding. To address this, economic responses were modelled across the range of milk yields and concentrate levels examined, based on an assumed milk price of 29 pence per litre, an assumed concentrate cost of £270/t, and an assumed silage cost of £130/t DM. This analysis demonstrated that while it may be financially viable to offer up to 14- 16 kg concentrate with cows of very high genetic potential offered low or medium quality silages, the 'break-even' level of concentrate feeding with a high quality silage is approximately 13 kg concentrate/cow/day. However, these upper feed levels will depend on cows in your herd having the genetic potential to respond to the extra concentrates offered. Cows without this genetic potential will simply partition energy from the extra concentrates offered to body fat, resulting in overfeeding and a poor economic response. However, if milk price was to fall to 26 pence per litre, the 'break-even' level of feeding with a high quality silage will be approximately 10 kg/cow/day, thus highlighting the impact of milk price on optimum concentrate feed levels.

For further information on AFBI research relating to concentrate feeding strategies for dairy cows, contact Conrad Ferris (conrad.ferris@afbini.gov.uk): Tel: +44 (0)2892 682484

The full results of a number of these studies are available in booklet form (Booklets 27, 30 and 33) on the AgriSearch website (www.agrisearch.org)





AFBI - Dairy Innovation in Practice

Trevor Gilliland

The Northern Ireland dairy industry is facing a number of challenges that threaten current levels of productivity as well as the competitiveness of local milk production in world markets. Some of these are clearly defined, such as the need to control phosphate levels on the land and in waterways, or the need to reduce greenhouse gas and ammonia emissions. Others, such as the implications of the UK exit from the EU, are as yet less well defined and quantified. However, AFBI researchers are working to create innovative solutions that can be adopted on-farm to protect the local industry and enhance its competitiveness globally. The ongoing challenge is clearly evident in Figure 1 where the red line shows the deflationary true value of milk prices today compared with the early 1990's. It shows that in 2016, dairy farmers were operating at what would have been less than 15p per litre over 20 years ago. The only coping mechanism available is to continue to focus on efficiencies in the production process. This is where AFBI's scientific innovations make a vital contribution.

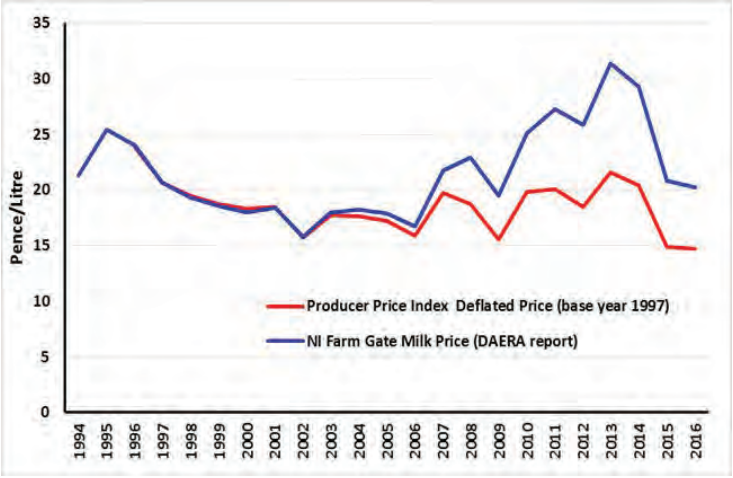


Figure 1 Deflating true value of farm gate milk prices
(UK, GB and NI Farmgate Milk Prices, Defra 17 August 2017)

The current series of AFBI on-farm research demonstrations clearly show how efficiencies and precision at every step in milk production are necessary to optimise the performance of the farm business. This principle applies equally from preparing the cow pre-calving to youngstock management and cow health protection, as it does to the management of soils and grassland with the strategic use of concentrate feed. This is also true for all measures needed to protect the environment. The key is a holistic approach, as neglecting any aspect can easily offset all the 'best practice' gains made elsewhere. Some of the headline findings of the AFBI dairy research work can be summarised as follows:

Building from the ground up

The fundamentals of correct soil management have been known for many years, but AFBI soil scientists have fine-tuned these principles to Northern Ireland conditions. The key messages from AFBI studies are to regularly soil test (at least every 4-5 years), to maintain a soil pH of at least 6.0, a correct balance of base nutrients and to identify and alleviate symptoms of soil compaction. There is still much work to be done at farm level, as AFBI studies have shown that more than 50% of local grasslands are under-limed, potentially losing up to 2t DM/ha/yr. Similarly AFBI has found that potash deficiency is occurring in 15-20% of silage swards, which is depressing yield by up to 30%. On the other hand, more than 30% of land has surplus potash levels that can exacerbate animal health problems. Similar issues with excess phosphate levels on-farm remains a serious environmental issue. It is in these areas of mismatch that AFBI's soil scientists are now focusing their efforts and a large multimillion pound EU Interreg funded programme of work is underway.

Calf and heifer management

AFBI research on commercial farms as well as at the AFBI Hillsborough research farm, has clearly shown that setbacks or detrimental effects experienced by calves in their early life carries through to depressed performance in later life. A critical abatement measure is good colostrum management. Following an extensive range of complex research studies, a number of simple principles have been established that can easily be applied on farm. Calves need to receive 8.5-10% of their birth body weight in colostrum within the first hours of life, as they lose the ability to absorb Immunoglobin G within 24 hours. AFBI research has shown that maintaining hygiene at calving, during colostrum collection and milk feeding, and within an aerated but draft free calf house, and following necessary vaccination

protocols all contribute to improved calf health and lifelong performance. Closely following these measures will avoid significant financial losses as even a calf that suffers an ill health setback but recovers, will take longer to reach breeding weight; calve at greater than 24 months of age and cost at least an additional £175 to rear.

Strategic control of concentrate feeding for dairy cows

With concentrate feeding constituting between 60-70% of the variable costs on local farms, this has been a key target of AFBI's research efforts. This has become even more of a critical need given the clear trend between 2000 - 2014 where the amount of milk from forage has been declining and replaced with more expensive bought-in concentrate (Figure 2). However, it is encouraging to see that since 2014 the trend has changed as more farmers implement AFBI research backed guidelines on how to include more forage in the diet, whilst maintaining milk yield.

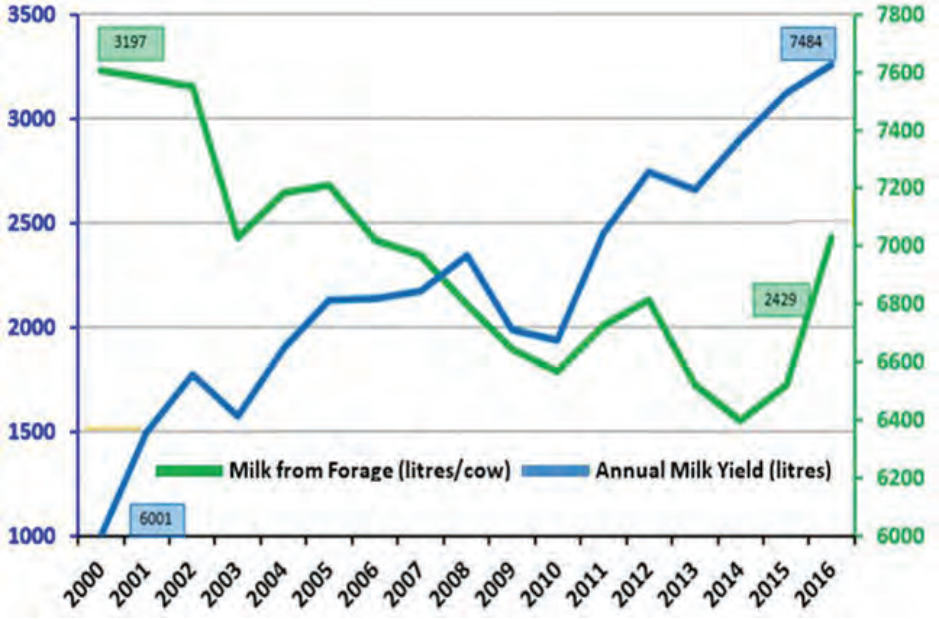


Figure 2 Trends in milk yield & milk from forage (CAFRE Benchmarking data 2016-17)

While the highest yielding cows, producing 12,000 l/year and above, have very high energy demands, AFBI's research has shown that strategic use of concentrates can be achieved without compromising cow performance or condition, particularly during the winter period. Critical issues that AFBI research has identified include ensuring that cows are dried off at the target condition score (2.75) for calving. Otherwise, recovering from thin cow body condition is extremely difficult and impacts both on calving performance and later milk productivity. Furthermore, feed rates should not exceed 0.45 kg per litre in feed-to-yield systems based on a 'corrected milk volume' that accounts for milk composition. Such in-depth understanding of the dairy cow's nutritional requirements, which has come from extensive AFBI research studies, provides local farmers with vital and precise guidelines of how to extract maximum value from expensive concentrate feeds.

This year the quality of silage samples analysed by AFBI's Hillsborough Feeding Information System (HFIS), shows a substantial improvement over the 20 year average values (Table 1).

Table 1. Comparison of farm silage quality analyses (data AFBI Hillsborough Forage Information System - HFIS)

	Dry Matter Content (%)	Crude Protein (% DM)	Metabolisable Energy (MJ/kg DM)	Feed intake Potential (g/Kg W0.75)	Milk yield potential of silages as the sole feed (kg/d)
First Cut Silages					
2017	33.5	11.9	11.2	99.5	12.0
20yr average	25.4	12.2	10.8	91.1	8.6
Second Cut Silages					
2017	30.4	12.1	10.8	96.6	10.1
20yr average	25.2	12.5	10.5	88.9	7.3

Across all farms that have submitted silage for analysis at AFBI this year, this year's first cut silage has much higher dry matter and metabolisable energy (ME) contents, and a higher feed intake potential, than in previous years, and this is reflected in the much higher milk yield potential of this year's silage. For example, when offered as a sole feed, this year's first cut silage will support up to 12 litres of milk per day, compared to average first cut silage, which will normally support 8.6 litres. Similarly, initial results of second cut silages shows an increase in dry matter and ME content compared to the twenty year average, and this is reflected in an increase in potential milk yield of 2.8 litres per day. So there is considerable potential for savings in concentrate feed use over the winter period this year. However, the extent of the savings in concentrate feed rates which are possible this winter requires accurate analysis of silage, such as that provided by the AFBI Hillsborough Feed Information System.

Animal health and welfare

The AFBI Cattle Health Scheme (CHS) now it its 10th year, provides NI farmers with a unique tool to uplift herd health and reduce the significant financial losses associated with mortality, veterinary care and drug costs. The CHS scheme targets the five most prevalent diseases in cattle, ie (Bovine Viral Diarrhoea (BVD), Infectious Bovine Rhinotracheitis (IBR), Leptospirosis, Johne's Disease and Neosporosis and the scheme members are provided with support and evidence on eradication strategies. AFBI scientists provide the local dairy industry with a strong support base to protect and enhance animal health and welfare. Key roles include post-mortem testing of fallen animals and wide range of diagnostic tests on live animals. They also provide key expertise in animal physiology and pathogen infection and as such advise the local industry about major risks and how to ensure local herds are not affected. Public opinion is increasingly focusing on farm animal welfare and this is influencing farming practices. It is essential that the dairy industry relies on scientifically validated, independent evidence of high welfare status.

Northern Ireland's green asset.

Grass growth in Northern Ireland occurs when soil temperatures are consistently above 6^{O}C at 10cm depth, which generally aligns with a mean daily air temperature above 5.6^{O}C. While this takes little account of rainfall or ground conditions, the majority of our local grassland has a growing season between 235 days (late March to early November) and 265 days (mid-March to early December). On upland extremes it can be as low as 205 days but in East

Down and from the Ards Peninsula to Belfast Lough, it can reach or exceed 280 days. This results in the very high yield potential that good perennial ryegrass swards can attain. AFBI research has shown that it is possible to grow 15t DM/ha on-farm (around 90t/ha fresh weight at 18% DM) with 80% of what is grown being utilized. However, research undertaken by AFBI has shown that **pregrazing herbage yield on many farms is too high** (above 3000kg DM/Ha), as shown in Figure 3. This is driving down grass utilization levels on-farm. As a consequence, the average production across dairy farms is only 7.5t DM/ha with average utilization down to around 50%.

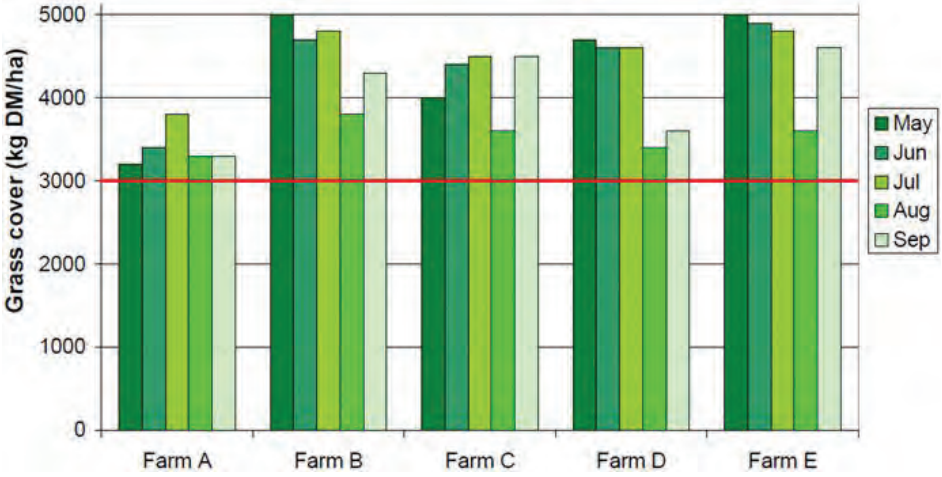


Figure 3: Dairy farm pre grazing grass covers across the grazing season (AFBI results) (Target should be 3000 kg DM/ha)

The underutilisation of grass on many farms is a major challenge and is a key issue that AFBI scientists are seeking to correct through the GrassCheck forecast service in collaboration with AgriSearch. This has already demonstrated that it is possible to grow 12-15t/ha DM on-farm and that extending grazing further into the autumn is worth over £1000 additional profit per week on a 100 cow farm. Furthermore, adopting a new approach to grassland management and improving milk from forage by 1000 litres/cow provides an additional £10,800 in annual net margin on the average dairy farm. In recognising that ground conditions and soil type will limit what can be achieved in practice, this year GrassCheck has spread out across Northern Ireland using thirty monitor farms (12 dairy and 18 beef farms) that represent much of the variability across local farmland (Figure 4). The GrassCheck service

was created from the knowledge gained in many strategic research studies into grassland growth which eventually made it possible to build the prediction models we use today.

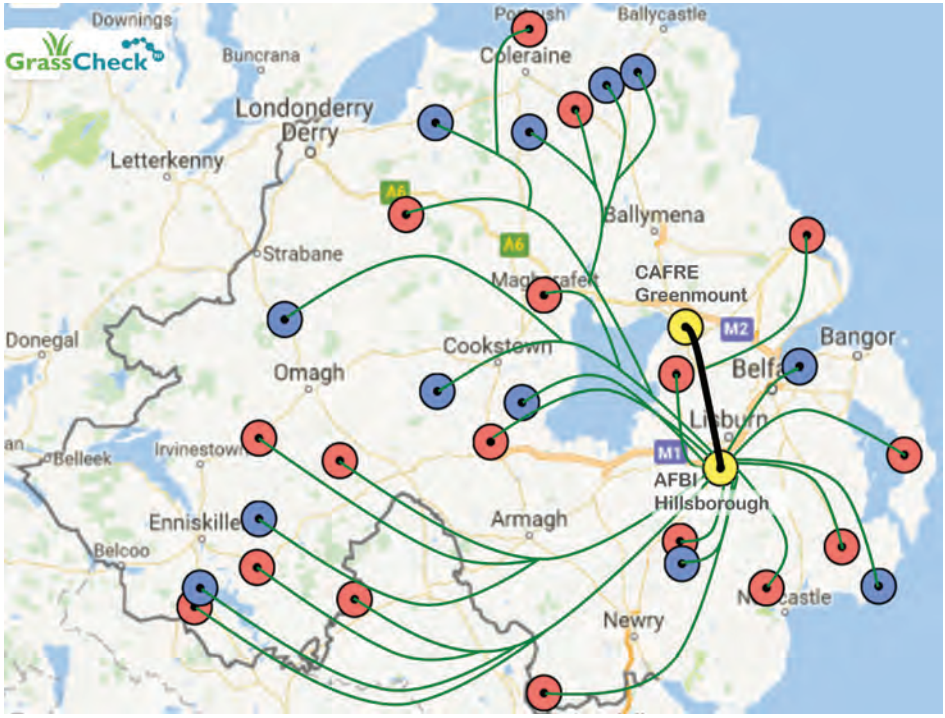


Figure 4: Network of the 30 on-farm GrassCheck sites across Northern Ireland

GrassCheck is a clear example of AFBI science in action on-farm and demonstrates the value of AFBI researchers building a body of knowledge and expertise over an extended time period. Some research projects address specific problems that need immediate solutions and these are normally very applied and time-bound studies. However, to generate the type of innovative knowledge and step changes that GrassCheck offers farmers, requires AFBI researchers to engage in more long term 'programmes' of work.

AFBI Innovations – the next chapter

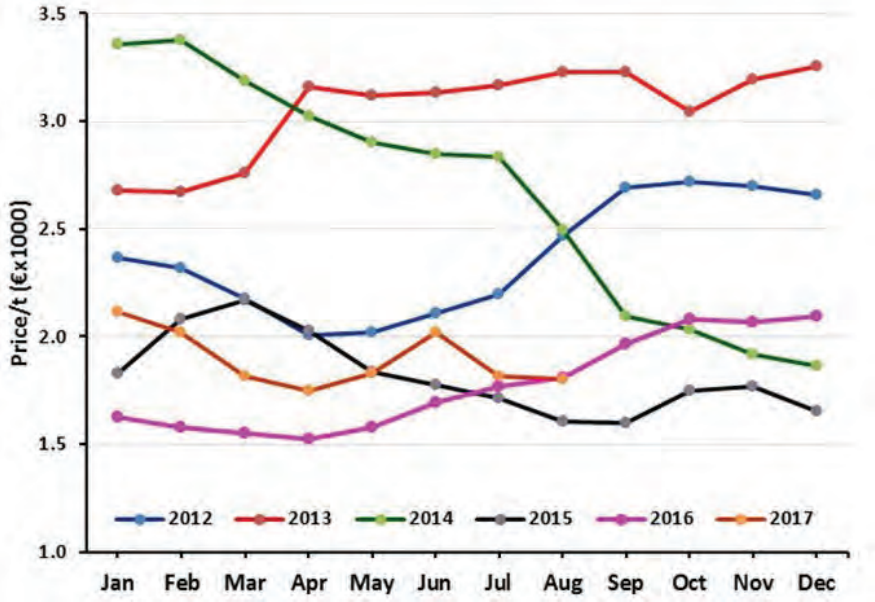
The arrival of so many new digital technologies for continuous and accurate measurement of animal responses and behaviours, is opening the opportunity for AFBI researchers to conduct animal studies with far greater precision than ever before. This has largely been made possible by funding that AFBI researchers have received through AFBI's role as a founder member of the UK Centre of Innovation Excellence in Livestock (CIEL). This is a UK Government pump-prime funded collaboration of industry and research institutes.

Given this additional funding and a targeted investment by AFBI in new dairy research staff and postgraduate scholars, AFBI's research is moving into a new era with an increased focus on grass production and utilisation, whilst also investing in the new challenges of application of genomic technologies and management of 'big data'. Central to this is the need to run large programmes of research over a number of years, to build the knowledge that will deliver the next generation of innovations into farm practices. AFBI's commitment to support the local dairy industry in the coming years is critical given the challenges ahead. Even without the big headline problems such as phosphate and ammonia control, or climate change mitigation or the forthcoming exit from the EU, the normal volatility of market prices will always mean that survival and success will depend on continuous efficiency improvements. This is clearly demonstrated by the in-year and between-year fluctuations in EU skimmed powder prices shown in Figure 5.

From the research presented in this booklet, which will be featured at the three on-farm events, it is clear that a grassland-focused Northern Ireland dairy industry has the potential to be amongst the best in the world at delivering a premium quality product, predominately from a renewable natural resource, at a globally competitive price. AFBI dairy researchers have a clear vision and ambition for what needs to be done to achieve this and this booklet presents some of the world class work that has been conducted to date. AFBI's dairy

research programmes will continue to develop novel solutions to industry challenges with the overarching purpose of enabling local farmers and businesses to thrive, whilst enhancing the overall environment.

Figure 5: EU skimmed milk powder prices 2012 – 2017
(Eurostat: http://ec.europa.eu/eurostat/ August 2017)

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AgriSearch - Delivering Value to Dairy Farmers

Summary

- AgriSearch is an independent charity 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 £300,000 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 £30 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 91kgN 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)	5.98	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

RESEARCH BRIEFS

Reducing the Environmental Impact of Dairy Cattle

Yiguang Zhao, Deborah Hynes and Tianhai Yan

Key messages

- Reducing the crude protein content of the concentrate offered to grazing dairy cows had the following impacts:
  - Lowered total nitrogen intake
  - Reduced N excretion to grassland and decreased milk urea N content
  - Had no effect on cow feed intake, milk yield or fat or protein composition
  - Allowed the use of a lower cost concentrate feed
- Grazed grass is an effective mitigation strategy to reduce methane emissions from dairy systems

An environmental concern relating to grazing management of dairy cows is associated with methane emissions and urine nitrogen excretion on the grass sward. Methane emissions originate from the rumination of cows and present a major challenge to addressing climate change. On the other hand the nitrogen component in excreted urine can be quickly converted to nitrates, ammonia and nitrous oxide which causes pollution to groundwater and the atmosphere.

Ammonia emissions are a particularly significant issue in Northern Ireland since per capita emissions are estimated to be approximately four times higher here than in the rest of the United Kingdom. High ammonia emissions can result in poor air quality that influences public health, and also the biodiversity of sensitive plants. Cattle production is a dominant source of ammonia emissions in Northern Ireland, contributing over 70% of total ammonia emissions in the country. The dairy sector therefore needs scientific solutions to mitigate this problem. If this could be achieved by lowering the levels of crude protein in concentrate feeds to reduce grazing urine nitrogen excretion, this could potentially benefit dairy producers both environmentally and economically.

Lowering the environment impact of Nitrogen.

Recent work at AFBI Hillsborough investigated the effect of low protein concentrates on feed intake, milk production and urine nitrogen excretion of lactating dairy cows. In the study in a zero grazing system, cows were offered daily-cut fresh ryegrass herbage and one of 3 concentrate supplements of different crude protein contents.

Concentrates were fed with the aim of providing 40% of total dry matter intake The 3 grass-concentrate diets contained crude protein levels of 16.9%, 17.6%, and 18.3% (on a dry matter basis).

The results indicate that cows offered a low crude protein concentrate had similar total dry matter intake, milk yield and milk composition when compared to those given medium or high crude protein concentrate diets. However, decreasing the dietary crude protein level from 18.3% to 16.9%, significantly decreased the total nitrogen intake by 8%, and urine nitrogen excretion by 11%.

Ammonia emissions from grazing cattle are predominantly produced from the nitrogen component in urine. The results from this study indicate that feeding grazing cows with low protein concentrate is an effective mitigation strategy for urine nitrogen excretion and consequently ammonia emissions. Using

low protein concentrates at grass not only increases economic return for the dairy industry, but also reduces the environmental footprint from the dairy production sector.

Lowering methane emissions from cattle

A second significant finding of the study was that the average methane emission as energy loss is 5.6% of total energy intake. This value is much lower than those of approximately 6.5% to 7.0% reported elsewhere across the world. This places grazing systems in Northern Ireland in a positive position. With regard to greenhouse gases, grazing cows contribute less greenhouse gas to the atmosphere, and have a higher proportion of energy that can be utilised for milk production, rather than lost as methane.

The overall conclusion from the study was that a reduction in concentrate crude protein content brought both economic and environmental benefits as it lowered the usage of costly crude protein sources, such as soybean meal. Furthermore, this study demonstrated that grazing fresh grass was an effective mitigation strategy for enteric methane emissions from dairy cows. Reducing methane emissions not only benefits the environment but also improves the economic return of dairy production.

Through this AFBI research study, farmers now have the evidence to take action to reduce urinary N excretion and methane production from their herds during the grazing season. The evidence shows that reducing crude protein levels to this degree will not impact on herd performance, but will help lower costs for milk production while lessening nitrates, ammonia and greenhouse gas emissions. Not only is this an environmental benefit, it can also contribute to an improved competitiveness for local milk production, selling into a world market.

For further information on the environmental impact of grazing dairy cows contact:

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Novel Sensor Technologies for Assessing Calf Health and Welfare

Gillian Scoley (AFBI PhD Student)

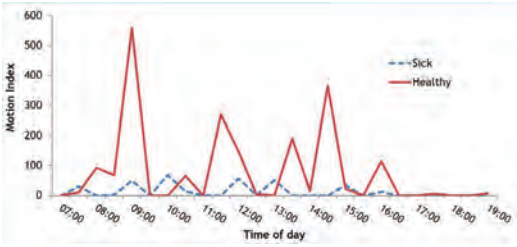
AFBI livestock scientists now have available to them a suite of new digital technologies that are revolutionising how they conduct their animal studies. These technologies enable scientists to make much more precise measurements which can automatically record and provide continuous real-time data uploaded to computerised databases. This article gives a brief overview of some of these systems and how they are being applied to accurately conduct calf health research studies.

Key Messages

- Stress and ill-health are a concern to the livestock industry due to impact on animal welfare and economic efficiency
- Traditional methods of assessing health and welfare are time consuming and potentially disruptive to the animal
- Increased need for reliable methods of assessing animal welfare during commercial farm practices
- Behavioural and physiological data from sensor technologies could be used to develop early warning systems for animal health and welfare status

Example novel technologies being employed include:

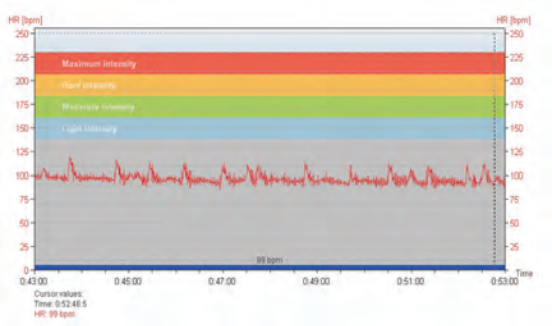
Activity Sensors



- Similar to sensors used on humans, this technology measures the number and duration of lying bouts and the total lying time in calves
- Calves have a high rest need ~ 80% of day lying
- Changes in lying behaviour, both duration and frequency, could be indicative of health and welfare issues

Heart Rate Variability

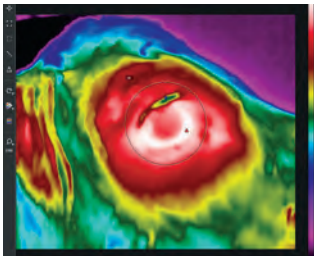
- Similar to the watch based technology used by health conscious people, this is a method of measuring physiological activity
- Allows real-time responses to environmental, pathological and psychological stressors to be monitored
- Increases in heart rate or decreased variability can be indicative of an increased stress load.



High heart rate variability equates to less stressed / healthier animals

Infra-red Thermography

- Stressor causes activation of hypothalamic pituitary axis = changes in blood flow = changes in radiated temperature
- Infra-red thermography detects small temperature changes
- Potential to correlate to core body temperature



Colour-coded infra red thermography

How these technologies are improving livestock science

The objectives are to use these digital systems to develop improved methods for assessing health & welfare. This could enable earlier diagnosis of ill-health, facilitating earlier and more effective treatment resulting in improved clinical outcomes.

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Gillian Scoley's PhD is funded by AgriSearch

Heifer Rearing Systems at Grass

Robert Patterson (AFBI PhD Student)

Key Messages:

The initial phase of this post graduate research project has indicated that:

- Increasing grass utilisation on farm is making a valuable contribution to profitability
- Opportunity for significant improvements in grazing practices for heifer rearing exist
- Heifer grazing research at AFBI is already showing opportunities to develop high efficiency, high precision grazing systems
- Well managed grazing can support heifer live weight growth targets

Importance of Grass

Feed costs make up a significant proportion of the costs associated with heifer rearing, with grazed grass remaining the cheapest source of high quality feed in ruminant livestock systems. Within Northern Ireland the average utilised grass yield on dairy farms is around 7.5t DM/ha with 12t/ha/yr being recognised as achievable and top farms achieving close to 16t/ha/yr.

The Problem

Young leafy ryegrass has a high nutritive value, which rapidly declines with increasing fibre concentration and seed head development. Grazed grass is a cost effective option to supply a high protein/low fat diet. However, as the young heifer is a highly selective grazer her grazing habit has to be taken into account when devising a suitable grazing system. A complex balance exists between feeding value, pasture production, animal performance and profitability.

A survey carried out on the grazing practices in heifer rearing systems at the RUAS Winter Fair revealed a number of trends, on the majority of farms:

- Heifer grazing is separate from the dairy herd, with set stocking and loose rotational systems dominating.
- Heifer grazing commonly extends onto silage aftermaths as the season progresses.

- Very limited weight recording of heifers is undertaken at grass and only one farmer surveyed measured and budgeted grass for heifers.
- 1 to 2 Kg of concentrates/head/day allocated throughout the first season at grass and 1Kg/head/day through the second season.
- Between 15 and 20 minutes spent checking heifers each day, whilst the average estimated time to move heifers at grass was 20 – 30 minutes.
- Frequent blanket fertiliser applications on heifer grazing was most common, followed by infrequent blanket sowing, with few farmers practising frequent rotational sowing.

Opportunities

There is significant potential to increase the efficiency of heifer grazing through a range of practices. Examples could include: earlier turnout date; a reduced dependence upon concentrates at grass; the adoption of stricter grazing systems; recording of animal performance; grass budgeting and more timely and efficient use of fertilisers.

Grazing Study 1

This heifer grazing study is evaluating a range of grazing systems in terms of sward and animal performance.

Design - Heifers born from late autumn into mid-winter (Fig. 1) were either continuously or rotationally stocked, the latter at approximately 3 or 6 day residence in paddocks.

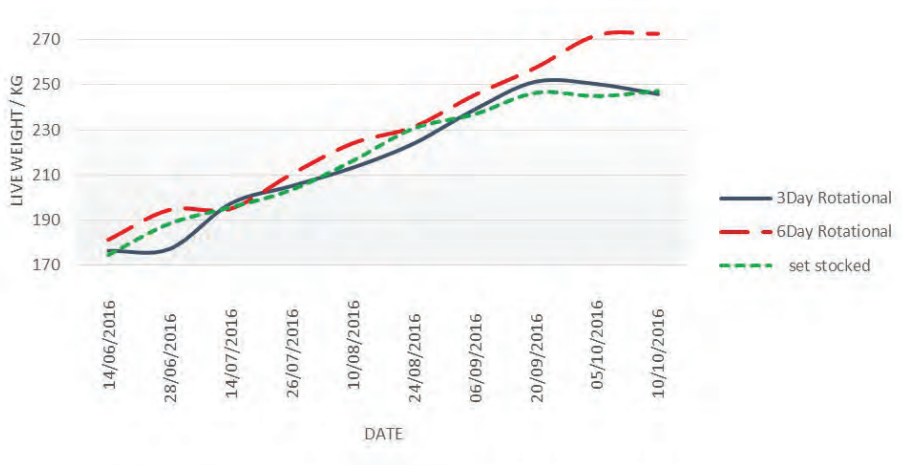
Figure 1. Nine month old heifers on paddock grazing trial at AFBI, Hillsborough.

Animal performance on the three grazing systems was compared and related to animal behaviour, herbage quality and herbage utilization.

Full data analysis is ongoing, however preliminary results show that within a 4 month period (spanning mid-Jun to mid-Oct) the 3 day rotational treatments utilised 7.8t DM whilst the 6 day rotational treatment utilised 8.0t DM. The 3 and 6 day treatments conserved 0.9t DM and 0.5t DM of surplus grass respectively.

The early indication from the results shown in Figure 2, suggest that animal performance was lowest in the continuous grazing treatment, with greatest performance observed with the 6 day rotational treatment. Further analysis and investigation is underway to verify these initial observations and to understand the causal factors behind the different responses at 3 and 6 day rotations.

Figure 2. Treatment effects on live weight of heifers on either 3 day or 6 day rotations or set stocking.



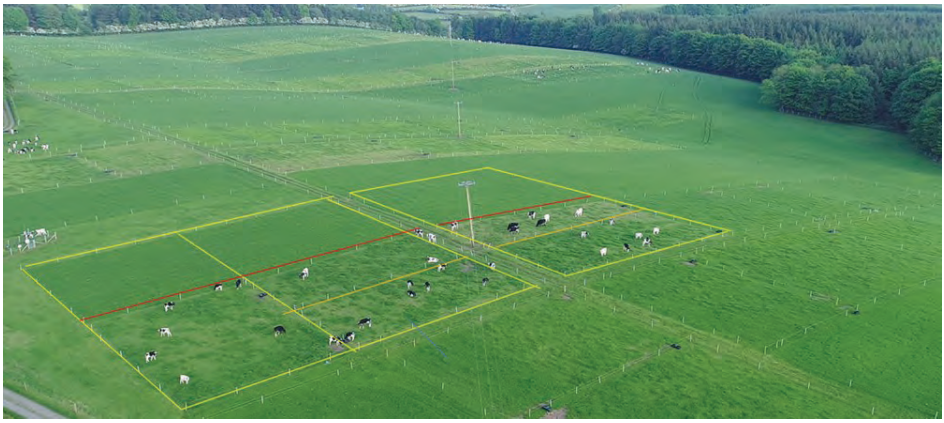
Grazing Study 2

This study is investigating the optimum pasture allowance for replacement dairy heifers, to achieve optimal animal and pasture performance.

Design - 72 dairy heifer calves born between September and December 2016 were allocated into 3 treatments of 1.8%, 2.4% & 3% of heifer live weight in kg DM/day of grass (Figure 3). The study commenced on the 6th April 2017

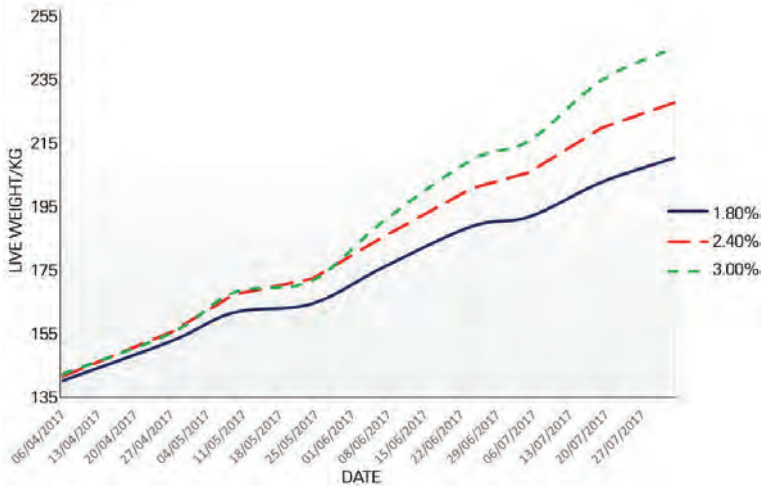
and is planned to run until early November. Heifers are weighed fortnightly, pasture growth and utilisation is measured daily and grass quality and sward composition is measured weekly.

Figure 3. Drone Footage of paddock perimeters used to set pasture allowances at 1.8, 2.4 and 3% of LW as kg DM/day in grass.



Preliminary results from the ongoing study show the lowest pasture allocation treatment at 1.8% has the highest pasture utilisation and pasture quality, whilst 2.4% and 3.0% allocations are currently delivering advantages in heifer live weight gain (Figure 4).

Figure 4. Treatment effects on live weight of heifers recorded weekly depicting effect of pasture allowance.



Future Study

Moving forward with the results of optimum heifer performance from grass alone the focus will be directed to within animal variations.

Precision technology will be applied in an effort to optimise grazing management and investigate the strategic use of concentrates at grass to maximise feed conversion efficiency. This will include the use of an individualised concentrate feeding station set up in the grazing platform. This technology will make it possible to monitor individual animals within the herd groups, to identifying and quantifying animal variation.

Acknowledgements:

This PhD project is funded by the Agricultural and Horticultural Development Board (AHDB).

For further information on grazing management of dairy heifers, contact:

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Factors Affecting Feed Efficiency and Rumen Development in Dairy Calves

Joshua McDowell (AFBI PhD Student)

Key Messages:

The initial phase of this post graduate research project has indicated that higher levels of milk replacer feeding coupled with a prolonged step-down weaning strategy has the following benefits:

- Minimises the commonly observed post wean growth slump
- Gains in live weight were maintained into later life

The Challenge

The objective of dairy heifer rearing is to achieve adequate growth rates to reach first calving between 22 and 24 months of age. However, average calving age is currently 28 months in the UK and with rearing costs beyond 24 months being estimated at £2.87/day, this presents a significant financial burden on dairy systems. Recent research has shown that feeding calves an elevated plane of nutrition has the potential to increase heifer growth rates and first lactation milk yield. However, problems have also been associated

with feeding large quantities of milk with complications such as latent rumen development, and depressed growth rates during transition from a liquid based diet to a solid based diet.

Aim: To assess the physical and biological nutritional requirements to reduce age at first calving and increase milk production efficiency

Objectives

- Assess accelerated versus conventional milk replacer provision and provision of forage type on performance during the weaning period
- Determine the effect of milk rearing regime and forage introduction on feed intake, methane emissions and energy and nitrogen utilisation efficiency of pre-weaned calves
- Investigate effects of milk rearing regime on growth, residual feed intake, digestibility and gaseous exchange of post-weaned calves
- Examine maintenance energy and protein requirements of mature dairy heifer replacements when previously reared on accelerated versus conventional milk replacer programs

The Research Work:

Calves were assigned to an accelerated (1350g/day) or conventional (600g/day) milk feeding allowance and subsequently introduced to different forage types with provision of either chopped straw at 2 or 8 weeks of age, grass silage at 8 weeks of age or no forage. Individual animal feed intake was monitored throughout the weaning period.

Findings

Calves on the accelerated milk program were 11 kg heavier at weaning (Fig 1) than calves offered the more conventional milk replacer scheme. This weight advantage was maintained after weaning as shown in Fig 2 with average live weight of accelerated animals 44kg greater at 294 d of age than animals from the conventional milk replacer regime.

These preliminary results indicate the increased concentrate consumption by calves on the accelerated feed treatment at day 56, when milk replacer was reduced to 3 litres per day as shown in Figure 3.

Implications for farmers

The early findings of the project indicate that higher levels of milk replacer

feeding, coupled with a prolonged step-down weaning strategy, overcame the commonly observed post wean growth slump associated with high levels of milk intake pre weaning. Gains in live weight were maintained into later life and work is ongoing to ascertain if metabolic and general feed efficiency can be altered through pre wean nutrition. Forage inclusion in the pre wean diet resulted in greater overall levels of dietary intake but no difference in growth rate.

Figure 1: Live weight of accellerated versus conventionally reared calves

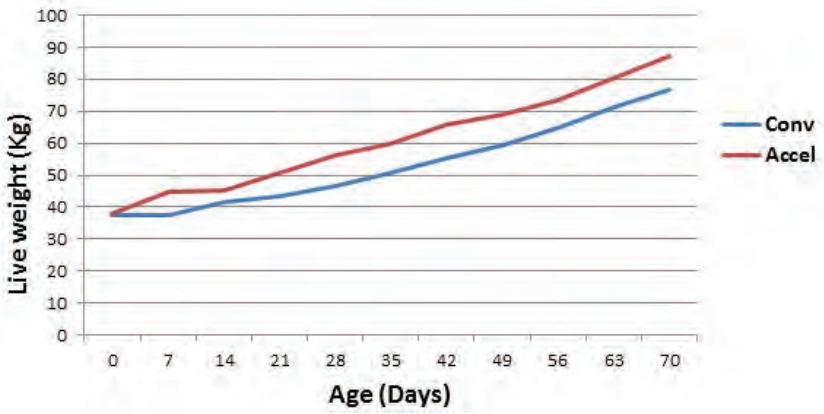


Figure 2: Post weaned live weight of accelerated versus conventially milk reared calves

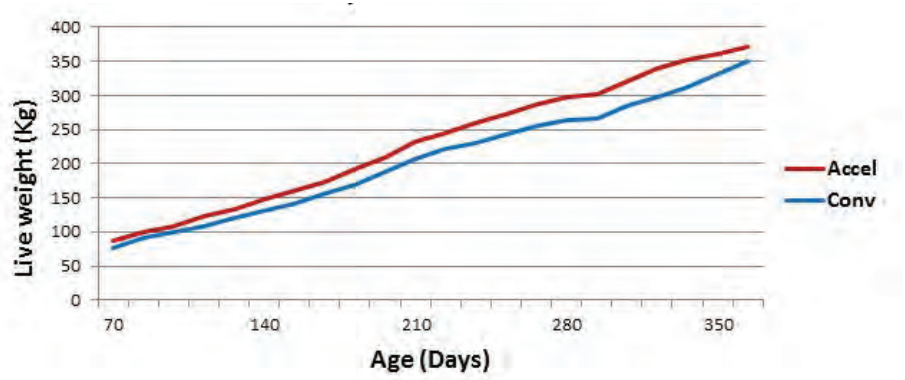
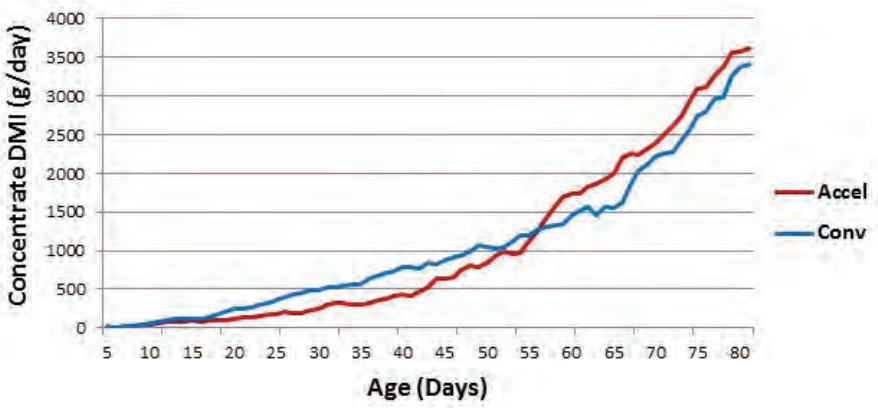


Figure 3: Concentrate intake of accelerated verus conventionally reared calves



Contacts:

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Acknowledgements:
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AgriSearch Driving Excellence & Innovation

Driving Innovation in Northern Ireland Dairying

Issues For The Dairy Industry:

- Major volatility in global dairy markets
- 88% increase in milk output (1980-2016)
- Increased yield/cow (currently 7000 litres/cow)
- Decline in milk from forage (and profitability) (3200→2500 litres/cow)
- Major environmental challenges – Phosphorous, Ammonia, Greenhouse Gases
- Plethora of new technologies

Aim of Today's Event

- Share latest research knowledge and innovation in:
  - Calf rearing
  - Grass production
  - Animal health
  - Winter feeding
  - Soil management
- Highlight how research results are being applied on farm to reduce costs and improve profitability.
- AFBI research – working in partnership with industry.

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MAP The Future

Measure

Analyse

Plan

Key targets based on research

- Calve heifers down at 24 months (measure heifer growth rates)
- Manage cattle health with an animal health plan (AFBI Cattle Health Scheme)
- Grow 12t grass DM/ha (Soil fertility ph, N, P, k + S)
- Utilise 10t grass DM/ha
- Produce 5000 litres from forage (Manage concentrate use carefully)

FOCUS ON PROFIT THROUGH EFFICIENCY

DAIRY INNOVATION IN PRACTICE

Ian McClelland, Creevy House Farm

Farm details

- Started farming at site in March 2015
- Current herd:
  - 70 Holstein-Friesian milking cows
  - 18 in-calf heifers
  - 20 calves
- Autumn – spring calving profile
- 4-cut silage + summer grazing
- 2017 – replacement dairy cow accommodation for 75 cows

Farm layout

40ha owned + 5ha conacre
All grassland

Ian McClelland, Creevy House Farm

Herd performance (July 2017)

Milk yield (litres/cow/year)	8598
Milk fat (%)	3.68
Milk protein (%)	3.18
Concentrate use (kg/cow/year)	2426
Milk from forage (litres/cow/year)	3206
Replacement rate (%)	30

Farm business targets

- Increase cow numbers by 30%
- Move to 100% autumn – winter calving profile
- Operate a closed herd policy
- Individual cow milk yield = 9000 litres/cow/year
- Maximise milk production from forage, achieving 4000 litres/cow/year

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Aidan McManus, Enniskillen

Farm details

- Converted from suckler beef to dairy in 2011
- 25ha grassland platform
- Herd size:
  - 2011 = 50 cows
  - 2017 = 110 cows
    125 followers
- Spring calving profile
- Operated a zero-grazing policy since 2013
- Installation of 2 milking robots in December 2016

Farm layout

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Aidan McManus, Enniskillen

Herd performance (July 2017)

Milk yield (litres/cow/year)	2016 = 7800 2017 projected = 9000
Milk fat (%)	3.95
Milk protein (%)	3.26
Concentrate use (kg/cow/year)	2000
Milk from forage (litres/cow/year)	3356
Replacement rate (%)	30

Farm business targets

- Move to 60-40 autumn-spring calving profile
- Increase milk production per cow without increasing concentrate use
- Individual cow milk yield = 9000+ litres/cow/year
- Reduce average age of herd
- Optimise management of cows on robot

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David Hunter, Newtownstewart

Farm details

- Converted from beef, sheep and arable to dairy in 2012
- Spring block calving system
- Current herd:
  - 80 Holstein- Friesian and Jersey-X milking cows
  - 15 in-calf heifers
  - 21 0-1 year old calves
- Whole farm reseeded in past 5-6 years
- Investment in laneways and grazing infrastructure to give flexible access to paddocks

Farm layout

40ha owned
All grassland

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David Hunter, Newtownstewart

Herd performance (July 2017)

Milk yield (litres/cow/year)	6250
Milk fat (%)	3.84
Milk protein (%)	3.22
Concentrate use (kg/cow/year)	1125
Milk from forage (litres/cow/year)	3750
Replacement rate (%)	35

Farm business targets

- Maximise use of grass by extending the grazing season
- Shorten spring calving period to 12 weeks
- Consistently achieve grass production targets of 14 – 15t DM/ha/year

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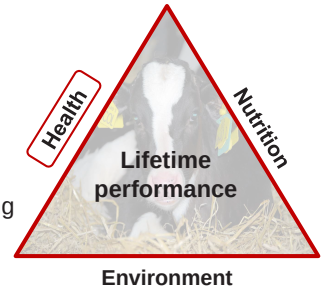
Calf Rearing - Back to Basics

Importance of dairy youngstock

- Best genetics
- Major investment
  - Heifer rearing costs £1,768 (£1,453 - £2,283) (Source: CAFRE)
  - Delayed age at first calving costs an additional £2.87/day (Source: AHDB)
  - Investment pay back takes 530 days from calving (Source: AHDB)



First few hours and days of life are critical

- Recent on-farm study indicates 6% mortality rate
- Poor colostrum management - calves 3X less likely to survive to 4 months of age
- 34% calves within AFBI on-farm study demonstrated failure of passive transfer of immunity

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Back to Basics – Long Term Impacts

On-farm study 17 farms (3237 calves)

- Calves that had scour were 2 times more likely to die within the first 4 months of life
- Calves that had pneumonia were 2 times more likely to calve after 26 months
- Calves that had scour were 56% less likely to be more than 125 kg at 4 months

Hillsborough based study (1881 calves)

	Pneumonia	Scour	Lethargic
Weight at weaning	-5kg	-4kg	-5kg
Weight at 18 months	-19kg	-12kg	-19kg
1st Lactation Yield	-170Litres	-33Litres	-592Litres

- Calves that suffer ill health:
  - Take longer to reach breeding weight
  - Increased risk of calving at greater than 24 months of age
  - **Extra £175 or more to rear**!

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Back to Basics – Colostrum Quality

KEY QUESTIONS

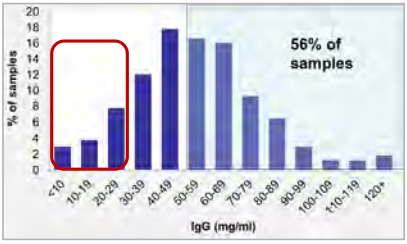
What is high quality colostrum?

- Colostrum with an IgG concentration more than 50 g/l
- Bacterial count less than 100,000 cfu/ml

What influences colostrum quality?

- Lactation number
- Breed
- Length of dry cow period
- Delay to colostrum collection
- Dam Vaccination
- Hygiene

Colostrum IgG level (ELISA) in farm samples



	Colostrum	Milk
Fat	6.4%	4.0
Protein	14.0%	3.2
Lactose	2.7%	4.7
TVC (000 cfu/ml)	17,800	17
SCC (000 cells/ml)	2650	195

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Back to Basics – Colostrum Quantity

- Calves typically require IgG intake of 120-180g
- Across 21 farms, 55% of calves were fed 3-4 litres of colostrum, 73% received colostrum within 4 hours of birth
- 10% of birth weight (approx. 3.5-4 litres) of colostrum as soon after birth as possible would result in adequate passive immune status in 86% of calves

Source: AFBI data	Colostrum Feeding Level	
	5% BW	10% BW
Calf birth weight (kg)	39.9	40.8
Colostrum fed at birth (litres)	1.9	3.8
Blood IgG level (mg/ml) 24 hour	12.3	20.6
Scour episodes	2.19	1.06

- AFBI research found no negative impact of higher levels of colostrum feeding on calf response to vaccination

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Take Home Calf Check List

Checklist

- ☑ Calving and colostrum management plan in place
- ☑ Feed 8.5-10% of birth weight of colostrum within first hours of life
- ☑ Colostrum quality tested routinely
- ☑ Calf immune status routinely assessed
- ☑ Calf health records kept and routinely reviewed
- ☑ Calf health and strict biosecurity plan in place and followed

Investing the time in designing and delivering an effective new-born calf management protocol will help maximise the lifetime performance of your dairy heifers

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AFBI Cattle Health Scheme

Addresses five of the most important endemic diseases of cattle:

- **Bovine Viral Diarrhoea**
- **Infectious Bovine Rhinotracheitis**
- **Leptospirosis**
- **Johne's Disease**
- **Neosporosis**

- Increases herd profitability through disease control and competitive advantage
- Certification of health status
- Licensed by CHeCS

Two important components
- Testing
- Biosecurity

AFBI supports the BVD eradication programme in Northern Ireland by:
- Providing high quality testing (ISO 17025)
- Performing research in support of the programme
- Providing expert advice to the industry

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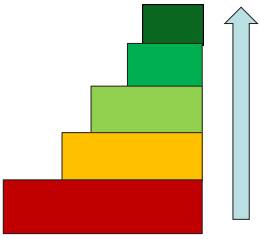
Johne's Disease

Dairy Risk Level Reduction Programme

Annual Herd Screen (>2 years)

High Risk	2 consecutive positive quarterly milks or 1 blood positive test
Medium Risk	1 quarterly milk test positive
Low Risk	2 consecutive negative quarterly milks or 1 blood negative test

- **Risk Assessment**
  - Within Herd Transmission
    - Early removal of infected cattle
    - Calf hygiene
  - Between Herd Transmission
    - Buy low risk
- **Testing**
  - Interpret tests in the light of herd history



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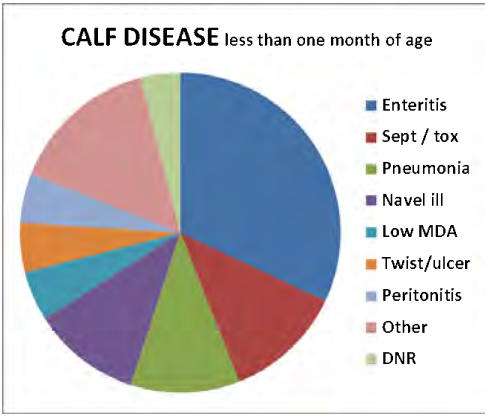
Calf Health



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

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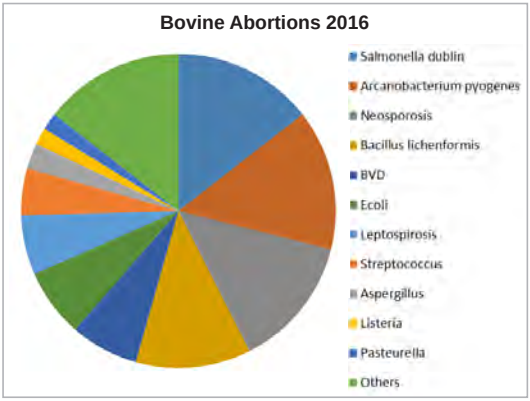
Bovine Abortion



- Investigation requires input from the farm veterinary surgeon AND THE SUBMISSION OF MATERIAL TO THE DIAGNOSTIC LABORATORY.
- Blood sampling of aborted cows may shed further light on the cause of the problem, but proper examination of foetal material is the best approach.
- Foetus and placenta are the best diagnostic samples.
- Submission of abortion material is as much to rule out some causes as to rule in others.
- Abortion may also be due to metabolic causes or due to placental failure.

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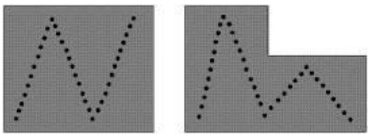
Soil Testing

Test your soil every 4-5 years

Benefits:

- Improve soil fertility
- Maintain the recommended pH 6.0 for continuous grassland
- Optimise grass yields and grass quality



How to soil test:

- Follow a zig-zag W-shaped sampling pattern
- 20-30 cores per field
- Avoid gateways, dung and urine patches, drinking troughs, headlands and animal resting places
- For fields more than 10 acres, split the field in two and collect a separate sample for each half
- Sample between October and early March

Cost:

- Roughly £1.86/ha or 75p/acre
- Cheaper than purchased fertiliser (>£80/acre)

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Lime and Slurry

Soil pH 6.0 is recommended for high-yielding perennial ryegrass and white clover swards

- 50% of grassland in NI is under-limed and potentially losing up to 2 t DM/ha/yr

- Maintaining the recommended soil pH is essential for nutrient uptake and optimum grass growth

Slurry is a valuable source of nitrogen (N), phosphorus (P) and potassium (K)

- Make the most of slurry nutrients by spreading in March and April prior to Spring growth
- Use low trajectory spreading techniques such as trailing shoe

- Trailing Shoe reduces N loss and can improve yields by up to 25%

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Essential Nutrients: Nitrogen, Phosphorus, Potassium, Sulphur

Nitrogen (N)

- Slurry is a valuable source of N.
- Maximum chemical N fertiliser on dairy farms 272 kg N/ha (8¼ bags/ac). Other farms 222 kg N/ha (6¾ bags/ac).
- Grass is often low in N at 2nd and 3rd cut.

Phosphorus (P)

- Too little P will reduce grass yields
- Too much P is harmful to the environment
- Regular soil testing indicates P requirement
- Target soil P Index 2: 16-25 mg/l Olsen P

Test your soil and monitor nutrient inputs. Nutrient surpluses can be as harmful as nutrient deficits

Potassium (K) (Potash)

- Potash increases the utilisation of N
- 15-20% of 1st and 2nd cut silage swards in NI *deficient* in K and suffering yield losses
- *Be careful*. High inputs of K in Spring can reduce the uptake of magnesium, a contributing factor in *Grass Tetany*

Sulphur (S)

- Many farms in NI have S deficiency, particularly at 1st cut silage
- Yield losses of up to 30% are common at 1st cut or 1st grazing as a result of S deficiency
- S deficiency can reduce the feeding value of grass, S being a key component of protein
- Apply S-containing fertilisers routinely

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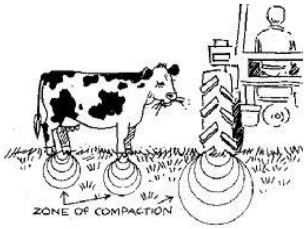
Soil Compaction



Soil compaction occurs as a result of repeated load on the soil surface such as animal trampling and heavy farm machinery

- Root penetration becomes difficult, aeration, water infiltration and drainage are reduced.
- Soil compaction can reduce grass yields by up to 25%

Preventing compaction by careful management is by far more cost effective than expensive remediation strategies such as subsoiling or reseeding.

Indicators of Compaction:

- Areas of surface water (ponding) following rainfall
- Patchy crop growth, often coinciding with wheel tracks and areas of heavy trafficking
- Soil with a 'cloddy' appearance and often containing blue mottles (through lack of oxygen)

Preventing or Reducing Compaction

- Timing: keep off fields when wet
- Large tyre diameter and width in combination with lower inflation pressure
- Reduce total axle loads (ideally below 5 t)
- Control traffic movement within fields to avoid repeated overlap of tracks

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Recognising the Value of Grass

- Grazed grass remains the cheapest feedstuff available to N.I. dairy farms
- N.I. dairy farm grass utilisation:

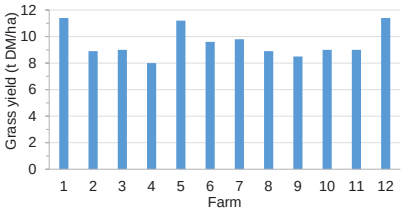
  Current average= **7.5t DM/ha** Potential = **12t DM/ha+**

- 2017 GrassCheck dairy farms projected average grass production >12t DM/ha

CAFRE Benchmarking: Cow performance and net margin for bottom and top 25% of milk from forage farms 2000 - 2016

	Bottom 25%	Top 25%
Yield per cow (litres)	6893	6943
Conc. feed rate (kg/litre)	0.39	0.23
Milk from forage (litres/cow)	949	3394
Net profit (£/cow)	**292**	**556**

GrassCheck Project: March – July 2017 grass yield per farm (t DM/ha)



Every additional 1000 litres from forage = +£10 800 profit per 100 cows

Improving Grass Utilisation

Grazing Targets

Achieving target pre- and post-grazing herbage mass crucial to maximising grass utilisation. Leads to:

- Higher intakes of good quality pasture
- Increased milk yields
- Reduction in herbage wastage
- Higher quality re-growths
- Shorter re-growth interval
- Improved response to nitrogen fertiliser

Post-grazing	**Pre-grazing**	**Remove**
1600 – 1800 kg DM/ha	3000 – 3300 kg DM/ha	> 3500 kg DM/ha

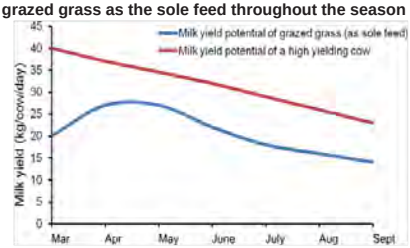
Regular measurement is key to achieving correct pre- and post-grazing targets

Concentrate Allocation at Grazing

- Efficient concentrate use during grazing season essential to reduce feed costs
- Study conducted with 138 cows at three M+ feed rates = 0.25, 0.45, 0.65 kg/l
- M+ values for: **Cows:** Start = M+ 21 litres, End = M+ 12 litres

  Heifers: Start = M+ 16.6 litres, End = M+ 9.6 litres

Potential milk yield of high yielding cows and of grazed grass as the sole feed throughout the season



Impact of concentrate feed rate on dry matter intake, cow performance and margin over concentrate

	Concentrate feed rate (kg per litre of milk produced above M+)		
	0.25	**0.45**	**0.65**
Conc. DMI (kg/cow/day)	1.7	3.2	4.9
Grass DMI (kg/cow/day)	11.9	12.3	10.9
Total DMI (kg/cow/day)	13.6	15.5	15.9
Milk yield (kg/cow/day)	19.0	22.0	22.4
Margin over conc. (£/cow/day)	4.07	4.88	4.50

Optimum feed rate = 0.45kg concentrate per litre above M+

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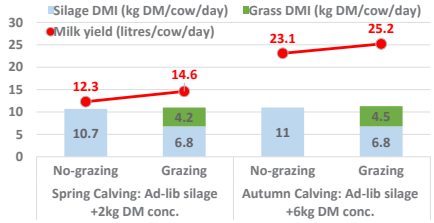
Extending the Grazing Season

- Well-managed autumn grass
  11.5MJ/kg DM+
- Opportunity to increase milk yields
  +2 litres/cow /day
- Delayed winter housing costs
- Each additional day at grass =
  + £1.55/cow

Impact of autumn grazing on silage intake and milk yield of spring and autumn calving cows



Managing autumn grazing:

- Infrastructure: tracks and multiple entrance points
- Short grazing bouts
- Daily grass allocation
- Back-fencing

Setting up for spring:

- Close driest paddocks first in autumn = first grazed in spring
- Avoid grazing heavy covers
- Evaluate infrastructure network
- Graze to target residual

One week's additional grazing for 100 cows is worth £1085

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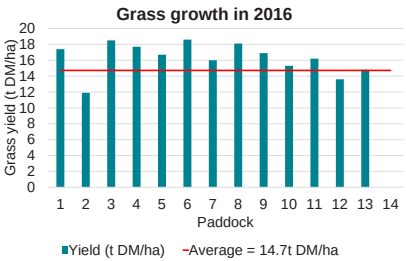
Grazing at Hunter Farm

- 20ha grazing platform
- 3.78 LU/ha
- All areas reseeded in last 6 years
- Tracks and fencing investments
- Target 14-15t DM/ha consistently



Current performance	
2017 yield to date (t DM/ha)	
Growth rate (kg DM/ha)	
Pre-grazing cover (kg DM/ha)	
Average farm cover (kg DM/ha)	
Rotation length (days)	

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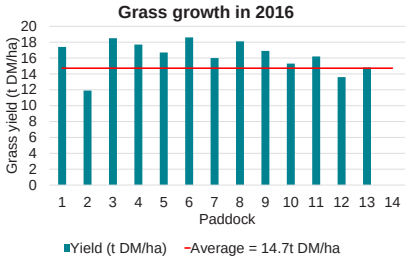

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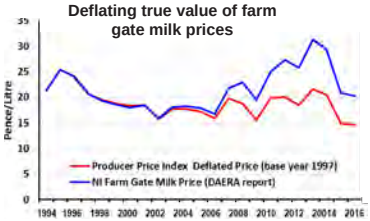
Innovation Challenges for Northern Ireland Dairy Farming

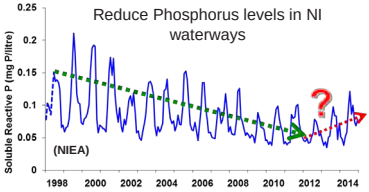
UK to exit the EU

- World prices?
- Tariffs?
- Lost markets?
- New competitors?

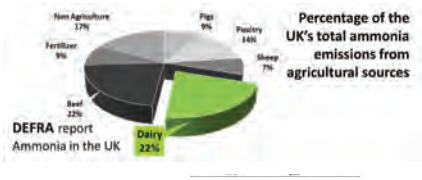
Perpetual drive for ever greater efficiency



Environmental Impact – Phosphorus



Environmental Impact – Ammonia



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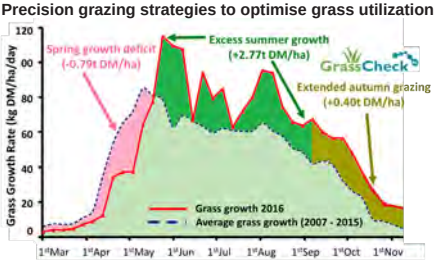
AFBI Innovation Driven Solutions

Making more milk from grass

Precision grazing strategies to optimise grass utilization



AFBI innovation messages

- Grass potential underutilized (max 16t DM/ha)
  - Top farms – 12-15t grown/80% utilized
  - Average farms – 7.5t grown/50% utilized
- Test your soil and monitor nutrient inputs
  - Surpluses can be as harmful as deficits
  - pH 6.0 for high yielding ryegrass/clover swards

Early life management strategies

AFBI innovation messages

- Calf rearing impacts on life time potential
  - Health problems delay breeding & first calving date
  - Extra £175 or more to rear
- First hours/days of life critical
  - Feed colostrum (typically 4L) within 1st hours of life
  - Absorption of immuglobulin G lost within 24hrs

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AFBI Innovation Driven Solutions

Strategic use of concentrate feeding

Trends in milk yield & milk from forage

AFBI innovation messages

- Potential to produce more milk from forage
  - Milk from forage well below levels in yr2000
  - Recent sharp recovery even with rising milk yields
- Optimum body condition at drying off
  - Dry off at body condition score 2.75
  - Thin cows recovery slow and reduces future potential

Cash in on 2017 High Quality Silages

Feeding 2017 grass silage can save concentrate input for a cow producing 30 kg milk per day

	First Cut Silages		Second Cut Silages	
	2017	20 year average	2017	20year average
Concentrate intake (kg DM/d)	7.5	8.8	8.2	9.3
Silage intake (kg DM/d)	12.1	11.0	11.7	10.8

AFBI innovation messages

- Exploit full potential of 2017 high quality silages
  - Increase 1st cut intake by 1.1. kg DM/day
    save 1.3 kg DM/day concentrate versus past 20 years.
  - Increase 2nd cut silage intake by 0.9 kg DM/day
    save 1.1 kg DM/day concentrate b versus past 20 years
- Balanced use of concentrate can reduce costs
  - Concentrate not exceed 0.45kg/L in feed to yield systems
  - Allocation corrected for milk quality/volume

A New Era of AFBI Livestock Innovation

"AFBI's new digital technologies for continuous and accurate measurement of animal production responses and behaviours, is allowing AFBI scientists to conduct animal studies with a far greater precision than ever before"

Life long precision feeding of individual animals

WiFi linked digital weather stations

Pedometers

WiFi linked GPS location platemeters

Thermograph for body, head, eye, foot, rectum etc temperature

Colostrometer

Heart rate monitor

In-field concentrate feeder

Equipment purchases supported by CIEL funding

Remote sensing and drone technology

Pasture optical sensors & GPS

Biocontrol Feed boxes

Automated feed, water & weight measurement

"AFBI's livestock research is entering a new era that will create the next-generation innovations for farm practices"

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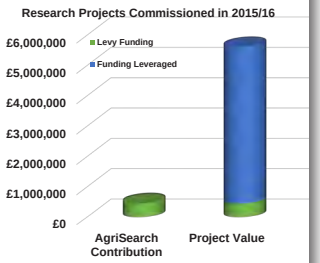
AgriSearch – Delivering value for dairy farmers

- AgriSearch is an independent charity
- **Purpose:** To help make the NI ruminant livestock sector more **competitive**, **profitable** and **sustainable**
- Levy of 0.02 ppl (£1.60 for a 8,000 litre dairy cow)
- 'Farmers Focused Research' - farmers have direct involvement
- Levy is used to leverage additional funding from other sources
- Reviews have shown a 22:1 return on levy investment (5-10% adoption rate)
- **Key Research Benefits To-Date:**
  - Lower organic N rate for NI dairy cows is worth £5.4 million annually
  - GrassCheck - provided evidence for £5.5M in weather aid / fodder aid payments
  - Potential to reduce costs by 5 ppl by applying AgriSearch co-funded research findings
- Committed to the driving research and innovation and the dissemination of research to farmers
- New ideas from the industry for research needs always welcome
- A wide range of resources are available on our website: www.agrisearch.org & social media

GrassCheck Pilot Farmers



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