Animal & Grassland Research & Innovation Programme

National Beef Conference

'Planning for Healthy Profits'

Tuesday 17th October 2017
Tullamore Court Hotel, Tullamore

Teagasc
Agriculture and Food Development Authority

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Teagasc National Beef Conference 2017

'Planning for Healthy Profits'

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Tullamore Court Hotel, Tullamore, Co. Offaly.

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Chaired by: Dr. David Graham, Chief Executive Officer, Animal Health Ireland

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Foreword

Welcome to the 2017 Teagasc National Beef Conference. An excellent panel of speakers has been put together covering a number of topics which address our theme of 'Planning for Healthy Profits'. Achieving profitability in your beef enterprise requires good management and an awareness and implementation of the new developments in the key areas such as breeding, grassland, animal health and financial management. Our conference this year will provide you with a good mix of technologies that are currently being used and research findings that, if incorporated into your business, will help you keep your focus on profitability into the future.

The first session will look at the three key areas of animal health, breeding and grassland. In the area of animal health we know from previous research that Liver fluke, and to a lesser extent Rumen fluke, have become more of a problem on many Irish farms. This has implications on costs and output so it is important that you know how to identify if you have a problem and the best strategies to deal with it while being mindful of anthelmintic resistance.

The Newford Suckler Herd, established by Dawn and Teagasc, will outline how they have managed to switch to 100% AI to avail of the top beef genetics, while also maintaining excellent fertility and compact calving. It has been said many times before, but grassland offers so much potential to beef farmers in terms of optimising animal performance, sustainability and it is our most cost effective feed. The reality however is that it is underutilised on many farms. The Grass 10 Campaign gives us an insight into how the top grassland farmers are able to grow and utilise in excess of 10tDM/ha and the technologies available to them.

Our evening session will provide an update on some recent research projects and the implications of their findings. One area where breeding efficiency could be improved in our suckler herd, is the age of first calving of replacement heifers. Even though we target calving at 24months the national average is nearer 32 months. The research examines factors impacting on heifer puberty.

Even though concentrates account for typically 7 per cent of feed dry matter intake annually in a calf to steer system, they account for 17 per cent of total annual feed costs. By examining the efficiency of low cost by-products concentrates in this paper, we look at the effect on the performance of growing and finishing cattle.
With over 900,000 calves available for beef production currently coming from the ever expanding dairy herd, a joint industry trial has been looking at the 'How can genetics play a role in a profitable dairy beef system'. In the future as beef farmers you will need to select calves from higher genetic merit sires if you are to maximise animal performance and profitability.

They say that 'to be forewarned is to be forearmed' and our last presentation from the Rural Economy Department examines the potential impact of Brexit on our beef industry.

Finally, can I take this opportunity to thank all of our speakers today, for their presentations and conference papers. I would also like to thank all my colleagues in Teagasc involved in putting together and organising such a focussed and practical conference. I have no doubt that each one of you will find today's conference enjoyable and informative, but the true measure of success is that you leave today with a clearer message of what technologies or research findings that you can implement to improve the profitability of your beef enterprise.

Professor Gerry Boyle
Director Teagasc

Improving the control of liver & rumen fluke in suckler cows and beef cattle

De Waal, T.
School of Veterinary Medicine, University College Dublin, Dublin, Ireland

Summary

- Rumen fluke (Calicophoron daubneyi) and liver fluke (Fasciola hepatica) share the same intermediate host snail: the mud snail Galba truncatula
- Biosecurity is important – always treat and quarantine bought in animals
- Grazing damp or waterlogged pastures is a significant risk factor, especially in a wet summer.
- Grazing management is an important factor in reducing risk to both liver – and rumen fluke
- Detection of rumen fluke eggs in faecal samples in itself is not a reason to institute specific control measures
- Liver fluke disease is always harmful and should be given priority, whereas rumen fluke only rarely causes disease
- Avoid the over-use of any flukicide to prevent the development of resistance

Fasciolosis is a parasitic disease caused by a trematode or flat worm *Fasciola hepatica* and can affect all grazing animals. Depending on the degree of infection it can be associated with economic losses of reduced meat and milk production. Fertility can also suffer and beef cattle affected by fluke may take an extra 80 days to reach market weights. Losses also occur due to livers condemned in meat plants.

Rumen flukes (*Calicophoron daubneyi)* are also trematode parasites which parasitizes the rumen of ruminants worldwide, but generally clinical disease tend to be confined to warmer tropical and sub-tropical areas of the world. However, in recent years, significant increases in the prevalence of rumen fluke infections have been noted in ruminant livestock populations across Western European countries. Although heavy burdens of immature rumen fluke can cause disease and sometimes mortality due to the damage caused to the intestinal wall, mature rumen fluke infections are usually of lesser importance, although negative impacts on production measures such as milk yields and growth rates have been reported.

Life cycle

Although the free-living stages of both the liver fluke and rumen fluke life cycle are affected by topography, temperature and rainfall, the basic epidemiology is very similar, however, the parasitic stages in the final host and its effects are very different. It is important to know the differences in the patterns, pathology and pathophysiology of infections between liver and rumen fluke in order to fully understand the likely course of disease, its treatment and control.

Life cycle of liver fluke (*Fasciola hepatica*)

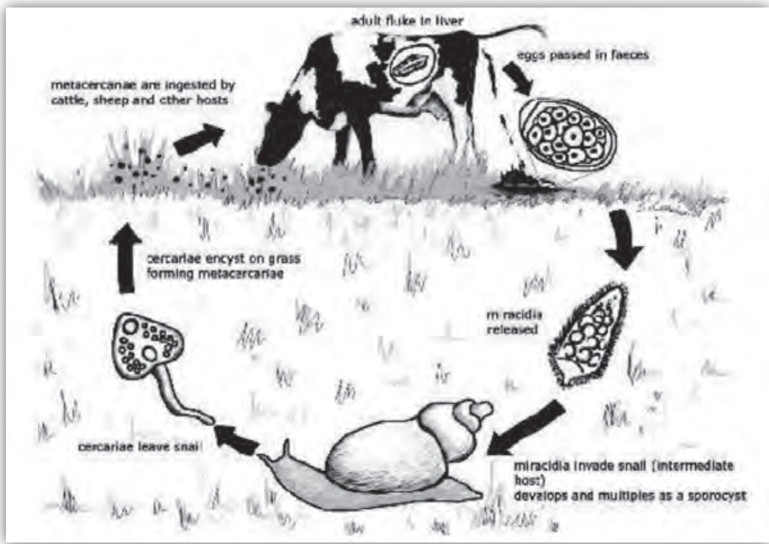


Figure 1 Liver fluke life cycle (AHI Leaflet - Liver Fluke – the facts[1])

Following the ingestion of encysted metacercariae by the grazing animal the juvenile liver fluke emerges from the cyst in the duodenum (small intestine). They then pass through the gut wall and penetrate the diaphragmatic surface of the liver capsule. The young fluke tunnel through the parenchyma over a period of around eight weeks, causing local damage, until they reach the bile ducts. In the bile ducts the flukes continue to grow, feeding on blood, and reach sexual maturity about 9–11 weeks post infection, after which egg-laying commences. The prepatent period is about 10-12 weeks. Eggs passed in the faeces into the environment develop and hatch motile miracidia (ca 10 days) which then infect a snail intermediate host, the mud snail (*Galba truncatula*), where further development takes place over a period of 6-7 weeks, under ideal conditions. Cercariae are finally released from the snail and encysts on vegetation forming metacercariae, ready to be ingested by grazing animals. The minimum period for completion of the one entire life cycle is about 17-18 weeks.

Life cycle of rumen fluke *(Calicophoron daubneyi)*

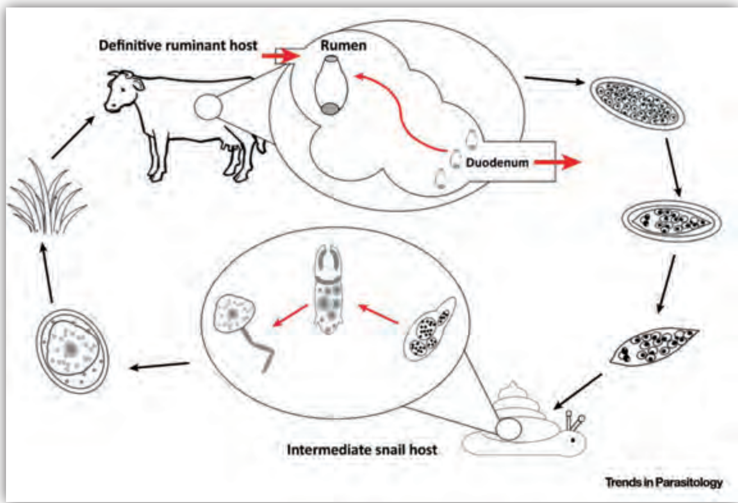


Figure 2 Rumen fluke life cycle (Adapted from Huson, *et al.*, 2017)[2]

1 *http://animalhealthireland.ie/?page_id=405*

2 *Huson, et al., 2017, Paramphistomosis of Ruminants: An Emerging Parasitic Disease in Europe. Trends Parasitol. 10.1016/j.pt.2017.07.002*

Following the ingestion of encysted rumen fluke metacercariae by the grazing animal the juvenile fluke emerges from the cyst in the duodenum (small intestine) and then follow a completely different migration pattern than liver flukes. The immature rumen flukes feed on the submucosa in the small intestine until they are ready to begin their migration to the rumen after about six weeks. In the rumen, mature fluke attaches firmly to the rumen wall, or rumen papillae, via their muscular sucker (acetabulum), and release eggs into the rumen contents. The prepatent period is between 7-10 weeks. Eggs are excreted in the faeces and, like the liver fluke, motile miracidia hatch from the eggs which then infect a snail intermediate snail host. Preliminary investigation suggests that the principal rumen fluke species in cattle in Ireland and UK also use the mud snail *Galba truncatula* as its intermediate host. Further development in the snail host occur over a period of four weeks, releasing cercariae which then encyst to form metacercariae on the ventral surface of sub-aquatic plants where they can remain viable for up six months.

Pathology and pathophysiology of infections between liver- and rumen fluke

Although the migration of juvenile liver fluke through the bovine liver will result in some local pathology, usually no significant adverse effects are observed on the general health, appetite and growth of cattle during this phase. However, cattle tend to be more affected during the chronic phase of the infection when there is extensive fibrosis of the parenchyma of the liver, and enlargement of the bile ducts with associated fibrosis and calcification. Chronic disease is usually seen in late winter and early spring but it is often difficult to differentiate the loss in productivity from inadequate nutrition. Several studies have highlighted the potential impact of liver fluke infection on reproductive performance and milk yield in cattle.

In the case of rumen fluke, it is the newly excysted and migratory stages of the immature flukes that are mainly responsible for clinical disease (paramphistomosis) in cattle. Clinical symptoms include lethargy/recumbency, dehydration, severe scour and submandibular oedema, which occur as immature parasites attack the duodenal mucosa causing significant damage to the tissues. Mortality may occur as a result of the damage caused to host intestinal tissue and symptoms of haemorrhagic enteritis. The adult rumen fluke in the rumen is generally well tolerated, even in very large numbers. Rumen fluke are anchored to the rumen papillae by a blind-ended muscular sucker and the oral opening (leading to the parasite gut) is pointed away from the rumen wall – suggesting that the rumen contents are the primary source of nutrition for the parasite. Never the less, some negative impacts on production measures, such as milk yields and growth rates, have been reported in some areas.

Implications for treatment and control

Grazing damp or waterlogged pastures is a significant risk factor, especially in a wet summer

Non-chemical control & pasture management

Reduce the possibility of exposure to liver and rumen fluke larvae on pasture by restricting access to fields, or parts of fields, which are or have been wet or water logged. Fence-off draining ditches, ponds and other watercourses as this will also reduce exposure. Reduce stocking densities, limit poaching of land.

Drug treatment

Different flukicides kill liver fluke at different stages of maturity, so it is important to know what stage is likely to be present to select the appropriate drug (Table 1). The aim of a treatment programme is to remove liver flukes to prevent damage to host which is commonly administered at housing to cattle that have grazed fluke-infected pastures. To avoid the overuse of triclabendazole or the need for two treatments of any of the other products during housing, 8-12 weeks apart, an alternative approach could be to delay treatment for eight weeks or more after housing to ensure that fluke are adult at the time of treatment with a drug only effective against the adult stages of the parasites.

Decrease pasture contamination for the following season by using a drug effective against adult liver fluke in late spring/early summer to prevent fluke eggs being deposited onto pasture and reducing the number of snails becoming infected.

Table 1: Efficacy spectrum of drugs available to treat liver- and rumen fluke in cattle

Chemical Name	Age of liver fluke killed	Route	Withdrawal period (meat)	Efficacy against rumen fluke
Triclabendazole	2 weeks onwards	Oral drench	56 days	None
Closantel	7 weeks onwards	S/C injection	49 days	Variable results
Nitroxynil	8 weeks onwards	S/C injection	60 days	None
Rafoxanide	8 weeks onwards	Oral drench	60 days	None
Albendazole	10 weeks onwards	Oral drench	14 days	None
Clorsulon	10 weeks onwards	S/C injection	66 days	None
Oxyclozanide	10 weeks onwards	Oral Drench	28 days	Good effect

Currently, oxyclozanide (normally marketed as a treatment for liver fluke) is the only drug with proven efficacy against immature and mature rumen fluke infections, although efficacy against immature *C. daubneyi* tend to be variable.

The detection of rumen fluke eggs in faecal samples, or the detection of the adults in the rumen is not in itself a reason to institute specific control measures. The routine implementation of a preventive dosing regimen for rumen fluke is rarely justified, except on farms where severe disease and losses have been confirmed in the past.

Current advice is to avoid the over-use of any flukicide to prevent the development of resistance. This is especially important in the case of rumen fluke where the indiscriminate use of a single compound like oxyclozanide over several years can rapidly lead to the development of resistance. Resistance of liver fluke to triclabendazole, albendazole and closantel has been reported.

The Animal Health Ireland website (*animalhealthireland.ie/)* provide valuable information in controlling parasite infection.

Using AI on a 100 cow suckler farm

Matthew Murphy, Farm Manager, Newford Herd, Athenry, Co. Galway.
James Keane, Teagasc Regional Manager, Mayo.
Michael Fagan, Livestock Systems Technician, Teagasc.

Summary

- 100 cow suckler herd bringing all animals to slaughter
- Cows are all first cross Angus and Hereford from the dairy herd
- AI used on farm every year with stock bulls used to mop up
- Targeting terminal traits in sires as milk is not a problem
- 94% in calf rate from 2017 scan on 1st August
- Stock bulls have now been sold and 100% AI will be used in 2018

Introduction

The Newford suckler herd was setup in partnership with Dawn Meats, Teagasc and The Irish Farmers Journal with the support of Mc Donalds. The suckler demonstration farm is located in Athenry, Co Galway. The aim is to demonstrate a profitable 100 cow suckler to beef enterprise from a grass based system. The system aims to finish as many heifers and steers from grass as possible at 20 months of age with the remainder being finished in the shed. I work full time on the farm with the support of Michael Fagan, a Teagasc technician as well as employing a student for three months in the springtime.

As the cows on the farm are Angus and Hereford first crosses from the dairy herd, producing milk is not a problem as these cows have good maternal traits. With this in mind we decided at the beginning of the project that if we were going to reach our finishing targets a lot of work needed to go into sire selection and maximising the terminal traits of our progeny. The decision was made to use AI on the cows and use two stock bulls to mop up after. This has worked out very well so far for the herd.

Why I use AI

As stated the cows on this farm are very good mothers – they have plenty of milk, are docile and go back in calf. The farm brings all progeny to slaughter and AI is a proven reliable tool to put terminal traits into our finishing cattle. The cows bring the milk and by crossing these with high reliability terminal bulls with good shape, carcass weight and confirmation - we have an excellent grass based finished animal. Trait reliability is a key component because high reliable terminal sires will have calves on the ground that will hit their performance targets and leave profit on the farm.

Putting it into practice

The main focus for me before I ever start breeding cows is the condition of the cows. We know that for a cow to start cycling as soon as possible after calving she should be at a body condition score of between 3 and 3.5 at calving. With this in mind we identified 22 cows at housing last November and fed 2kg of soya hulls until the end of December. I believe that this relatively short period of concentrate feeding had the cows in better condition at calving thus helping them return to heat much quicker.

At Newford, cows and calves went to grass on the 13th March and remained outdoors, full-time. At the beginning of April cows were already seen coming into heat and their numbers were recorded daily as part of routine herding. Weather and ground conditions were excellent and I was encouraged by the number of cows showing heat. The breeding season began on 24th April – AI was used for six weeks up until the 2nd of June when the two stock bulls were let in for four weeks.

Heat detection is the key to a successful outcome when using AI. To aid with this two techniques are used – tail painting and vasectomised bulls. We used tail paint on the cows to see which cows were coming into heat. This is a very cheap and effective way to see which animals are coming on and we topped this up once or twice during the breeding season. We also use two vasectomised Friesian bulls during the breeding season which have proven to be very successful. We purchased the vasectomised bulls (€850 each) and kept them in quarantine for 3 weeks before letting them out with the two groups of cows. The day they arrived on the farm they are blood tested and bloods are sent for analysis to Enfer Scientific to check if the bulls were carrying disease – results came back negative for both animals. A chin-ball harness, with paint, was fitted to each bull (this leaves a paint mark on the rump of the cow when the teaser is mounting the cow or resting his head on her rump). The teasers were let out with the cows at the start of the breeding season. One of the bulls was quiet for the first week but as more cows came into heat he became quite active and both bulls did an excellent job marking the cows.

Once-a-day AI was used in 2016 and it was so successful that we continued it this year. This means that if a cow was bred in the morning and was still showing heat in the evening, she would get another straw the following morning. It is important to point out that in 2016 an AI technician called to the farm daily, this year I carried out all the AI myself. This involved putting the marked cows (marked by the teaser bull) into the yard for AI at 12pm. The cows were checked at least 5 times daily and cows would be pulled out each morning from the two groups of cows. Cows are docile and with the help of reels, a paddock system and a farm roadway this was done quickly each morning without too much stress to man or beast. I was very sceptical of going down the AI route especially with two very good bulls on the farm. It takes time to check and get cows into the yard but in my opinion the calves on the ground and their performance have more than convinced me of the advantages of using AI.

The 10 week breeding period 2017 and the scanning results 1st August show that:

- 93 cows in calf out of 99 bred, a 94% in-calf rate
- 64 cows held to first service (65%)
- 18 cows held to second service (18%)
- 11 cows held to stock bull (11%)
- 6 cows empty (6%)

I am very happy with the results showing 93 out of 99 cows bred in calf. One of the key components of a profitable suckler system is that cows are in-calf. This in turn means you have a weanling, store or finished animal to sell at the end of the year. I was also pleased that 64 cows held to the first service which means we will continue to have a very busy calving period in February of next year. The empty rate of 6% is well below the national average and I would be quite satisfied if I can achieve this annually.

One major management decision made is to go 100% AI in 2018. As a result the two stock bulls were sold last month. The 2 stock bulls (SimmentaI,Limousin) were very successful on the farm and have great progeny slaughtered off the farm but it did not make sense to be holding onto two valuable bulls for breeding 11 cows. This decision was based on two years successful AI as we had an in calf rate of 98% from scanning results in 2016. Ironically, if the AI had not worked out so well over the last two seasons they would have remained in the herd. With such little work for them and the cost associated with maintaining them the decision was made to sell and go 100% AI in 2018.

Sire selection

One of the most important jobs I do each year is to select the terminal sires that we use on the herd. These are key decisions as the progeny of these bulls will be finished on the farm. It is critically important that the calves are easy calved, have good growth rates, perform well at grass, have good shape and confirmation, kill out well and most importantly leave profit on the farm. This is why each year I will spend a few evenings looking over the Irish Cattle Breeding Federation (ICBF) list of terminal sires. There is a very simple filter function on the list of AI bulls that allows a farmer to identify bulls with traits that are desired. By inputting the desired selection criteria into the computer search option it will highlight in seconds the available bulls.
The criteria for sire selection:

- 5 Star Terminal Index
- > 80% reliability
- < 7% calving difficulty for mature cows
- > 30kg predicted carcass weight for mature cows
- < 6% calving difficulty for the 1st and 2nd calvers
- > 25kg predicted carcass weight for 1st and 2nd calvers
- Straw costs less than €15

This is time well spent on any farm and it allows me to pick and choose the bull to suit my type of cows i.e. AA/HF with an average weight of 655kg. It is also worth noting than we make the decision based on the sire's terminal figures. Sire breed is not a factor in this decision. The table below shows the sires used in 2017

AI 5 Star's sires selected for 2017 breeding season (Main Herd)

Code	Sire Name	Breed	Terminal Index	Calving Difficulty	Reliability	Carcass weight	Reliability
F S Z	Fiston	CH	€150	6.80%	99%	37 Kg	99%
Z G M	Gamin	LM	€144	4.90%	97%	25 Kg	92%
LM4050	Wilodge GoldCard	LM	€153	4.60%	93%	31 Kg	87%

AI 5 Star's sires selected for 2017 Replacement Heifers

Code	Sire Name	Breed	Terminal Index	Calving Difficulty	Reliability	Carcass weight	Reliability
T H Z	Towthorpe Dubai	LM	€132	4.60%	99%	26 Kg	99%

We had used Fiston and Gammin in 2016 and are very happy with their calves on the ground at the moment. They were easily calved, have good shape and are performing exceptionally well on the cows. When these came up on the 2017 list we were happy to use them again. Another bull that we have tried for the first time this year is Willodge Goldcard and we chose him because he has exceptional figures for calving (4.6%), carcass weight (31kgs) and reliability of 87%. If this bull produces progeny easy calved and achieves the predicted carcass growth, he should have some great progeny on the ground next year.

Current stock performance

This spring was exceptionally dry and as a result cows and calves went out to grass in March. The calves born this year are predominantly sired by AI bulls as can be seen in the table below.

Main Herd Calf Weights 2017

Bull	Breed	Number of Calves	Lightest Calf Kg	Heaviest Calf Kg	Average Calf Wgt Kg	
C K H	C H	11	38	54	46	
F S Z	C H	37	30	57	46	2 Sets of Twins
Z G M	L I M	30	29	54	41	2 Sets of Twins
Stock Bull	S I	8	40	71	50	
Stock Bull	L I M	2	40	40	40	

First Time Calvers 2017

Bull	Breed	Number of Calves	Lightest Calf Kg	Heaviest Calf Kg	Average Calf Wgt Kg
E B Y	L I M	11	30	46	37
T H Z	L I M	10	36	44	42

The farm is always trying to maximise performance from every animal and this year the cattle performance has been good. We keep good quality grass in front of cows/calves and finishing stock at all times. This means that we can incorporate more grass into the animal's diet and therefore produce animals more profitably. The tables below show the most recent weights for each category of stock.

Performance of 2017 born stock

Weighing Date 11th September

Bull Calves 2017

Number	62
Average Birth Weight	46 Kg
Average Weight	303 Kg
Average Age	6½ Mts
A.D.G. From Birth	**1.30 Kg/ day**

Weighing Date 11th September

Heifers Calves 2017

Number	46
Average Birth Weight	40 Kg
Average Weight	276 Kg
Average age	6¼ Mts
A.D.G. From Birth	**1.23 Kg/ day**

Note : Castration was carried out on the 27th July

Performance of 2016 born stock

Cattle to be finished at pasture were identified by weight/conformation at the end of July. The steers and heifers received 5kg concentrate from early August while the remaining steers to be finished in the shed did not get concentrate at grass.

Steer/Heifer weights 5th Sep - receiving 5kg at grass from 28th July

	Weight (kg)	Age (mths)	ADG from Birth	ADG since turnout 14th March
Steers (20)	612	17.5	1.05	1.12
Heifers (42)	538	17.5	0.93	0.97

Steer weights 5th Sep - receiving no concentrate at grass

	Weight (kg)	Age (mths)	ADG from Birth	ADG since turnout 14th March
Steers (27)	521	17.5	0.89	0.88

Conclusion

Since the start of this project in 2015 we have been trying to maximise performance at every level on the farm – breeding, grassland, health and nutrition. It has become clear that the key to becoming a profitable suckler-to-beef farm is to use the best genetics available and that will work on this farm. In my opinion, to achieve a positive outcome I will use AI on all cows and will be able to predict the type of animal I will have at slaughter. AI might not suit every suckler farmer but for someone that was quite sceptical in the beginning – I will be sticking with it for the foreseeable future.

Lessons learned from the beef finalists of the Teagasc Grass10 Farmer of the Year Competition

John Maher, Teagasc, Grass10 Campaign Manager,
AGRIP, Teagasc, Moorepark, Fermoy, Co. Cork.

Background

Grazed grass is the cheapest and most widespread feed available for ruminant production systems in Ireland (Finneran *et al*., 2010). As an abundant natural resource, grass provides Irish farming with a significant competitive advantage for meat production (Byrne *et al*., 2015). Grass enables low-cost animal production and promotes a sustainable, green, and high quality image of beef production across the world; grass-fed animals have been linked to increased health benefits (Scollan *et al*., 2006). Recent industry reports (FoodHarvest 2020 and FoodWise 2025) have highlighted the important role grass can play in an expanding milk and meat production industry. Through a combination of climate and soil type, Ireland possesses the ability to grow large quantities of high quality grass and convert it through the grazing animals into high quality grass based milk and meat products.

Our competitive advantage in meat production can be explained by the relative cost of grass, silage and concentrate feeds (O'Donovan *et al*., 2011). Therefore, increased focus on grass production and efficient utilisation of that grass should be the main driver for expansion of the livestock sector. An analysis of farms completing both grassland measurement and financial farm analysis demonstrated increased profit of €105/ha for every 1 tonne DM/ha increase in grass utilised. It should be noted that issues such as environmental sustainability (carbon footprint, nutrient use efficiency) are also improved by increased grass utilisation.

Future growth in the pasture based meat production sector in Ireland will depend on an effective grass-based system. However, Irish farmers are not using grass to best effect and there is thus a need to (1) increase grass production and (2) ensure efficient utilisation of that grass.

Current Performance on Drystock Farms

Currently, it is estimated that about 5.6 tonnes grass DM/ha/year is utilised nationally on drystock farms, while the level of progress in pasture utilisation is outlined in the table below from Teagasc NFS data.

Table 1: Grass utilisation (tonnes DM/ha) for Irish drystock farms (Source: Teagasc NFS, various years)

	2014-2012	2013-2011	2012-2010
Beef – all farms	5.57	5.42	5.33

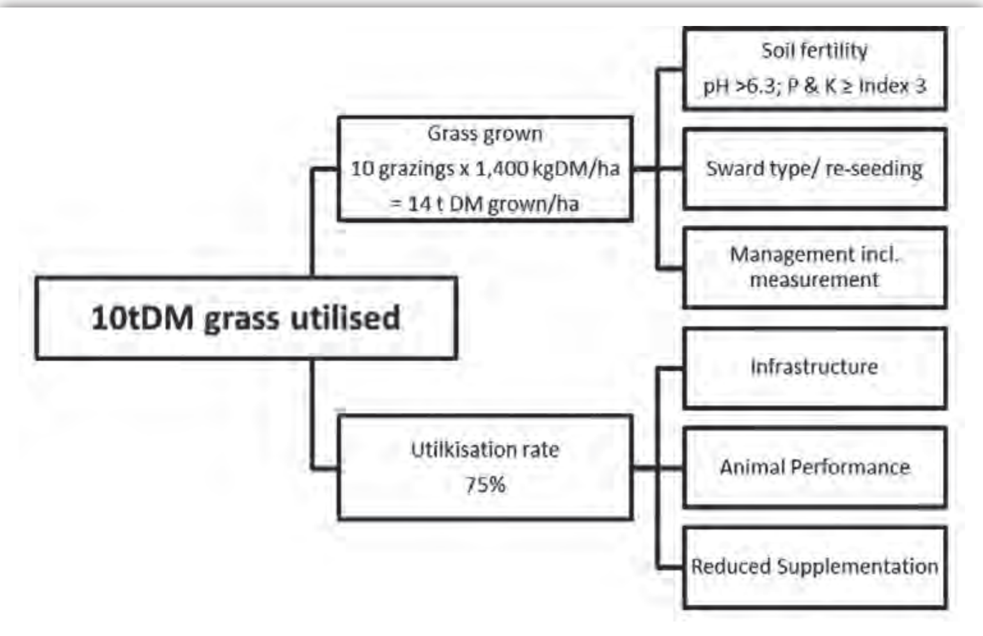
It is obvious from the table that the level of progress to date is low, at about 0.1t DM/ha/year. So there are major improvements required in areas of pasture production and utilisation. Data from the best commercial grassland farms and research farms indicate that the current level of grass utilised can be increased significantly on drystock farms (greater than 10 t DM/ha utilised – i.e. 14 tons DM/ha grown and 75% utilisation rate).

It is important to recognise that improvements in the level of soil fertility, grazing infrastructure and level of reseeding are in achieving higher levels of grass production and utilisation. However to achieve greater change in the level of grass utilised farmers will need to up-skill their grazing management practices. This means regular measurement of grass cover, using specialised grassland focused software to analyse grass production and making and implementing grazing management decisions. These are key drivers to increasing grass production on the farm. New technologies are now available which make grass cover assessment and the decision making process much easier.

However we must not underestimate the challenge of achieving change at farm level in achieving greater levels of grass production and utilisation. The results of recent NFS data demonstrate that the adoption, by farmers, of grassland related technologies is variable (Boyle, 2012). The adoption of technologies relating to reseeding and soil fertility testing is reasonable (and could also be improved) but the adoption of grassland measurement technology is quite low (<10%). However there is greater adoption of all grassland related technologies where technology transfer is focused through the use of the discussion group model (Bogue *et al*., 2014).

Grass10 Campaign

Grass10 is a new four-year campaign recently launched by Teagasc to promote sustainable grassland excellence. The Grass10 campaign will play an important part in increasing grass growth and utilisation on Irish grassland farms, thereby improving profitability at producer level and helping to ensure the long term sustainability of Irish beef, dairy and sheep production. Significantly, it can provide the platform or framework to enable various industry stakeholders to collaborate for collective action. Given the current performance in terms of grass growth and utilisation, the need for 'collective action' should be clear.



Objective

The objective of the campaign is to achieve **10 grazings**/paddock/year utilising **10 tonnes** grass DM/ha. In order to achieve this objective, we will need to achieve significant changes in on-farm practices, specifically:

1. Improved grassland management skills
2. Improved soil fertility
3. Improved grazing infrastructure
4. Improved sward composition
5. Increased grass measurement and usage of PastureBase Ireland

Grassland Farmer of the Year completion

With 2017 designated the Year of Sustainable Grassland, and a proven link between increased grass utilisation and increased profitability, the Department of Agriculture, Food & the Marine, in collaboration with numerous industry stakeholders including Teagasc, have recently launched a competition as part of the Grass10 initiative to find the Grassland Farmer of the Year. Teagasc research indicates that grass utilisation can be increased significantly on farm. With this background Grass10 has launched a grassland competition to recognise those farmers who are achieving high levels of grass utilisation in a sustainable manner. Practises used by these famers to increase grass production and utilisation include soil fertility management, sward renewal, grassland measurement and improving grazing infrastructure.

The objective of the Grassland Farmer of the Year Competition is to promote grassland excellence for all Irish livestock farmers

A number of farms in beef production have been shortlisted for farm visits as part of the Grassland Farmer of the Year competition assessment. There are many interrelated components required to produce high quantities of grass and to utilise large proportions of the grass grown. Some of the following practises were assessed.

1. Grazing Infrastructure

All the farms assessed had implemented a paddock system for grazing. However, these were either fixed or flexible paddock systems. Some farmers operated both flexible and fixed paddock systems.

Paddock Layout

Proper subdivision of grazing land into paddocks is essential to be able to successfully manage pastures and achieve desirable rotation intervals. Paddocks must be connected with an efficient roadway system so that the herd can move from one paddock to any other paddock on the farm.

Fixed or Flexible Paddocks

A fixed or flexible system of paddocks can be used for grazing – flexible paddocks should be considered by some farmers who are either constructing new paddocks, trying to develop paddock grazing or reorganising their existing systems. If we examine the advantages and disadvantages of both paddock systems, farmers should be able to decide which system best suits their own farm and management ability. Both paddock systems have advantages and disadvantages (see table). A fixed paddock system gives structure to grazing on the farm and will generally be more stock-proof. A flexible system would ensure better utilisation of grass in wet weather and less poaching damage. It would also result in quicker mechanical operations such as topping, cutting, fertiliser spreading, etc. In order to facilitate efficient grazing of silage fields in spring (before closing) and again the autumn, flexible paddocks can be operated. This would ensure no re-growths are eaten.

Advantages and disadvantages of fixed and flexible paddock systems.

Fixed Paddocks	Flexible Paddocks
Advantages	
Suits inexperienced operator	Less expensive to construct
Set area	Very flexible
See quantity and quality of grass ahead	Less under or overgrazing
Achieve recommended rotations	Interchange of grazing & silage fields
No daily movement of fences	Easier for machinery to work
Good electric current transmission	No weeds under wire
Encourages active grazing management	Easier to graze when ground conditions are poor
Disadvantages	
Expensive to construct	Higher level of grassland management ability may be required
Less flexible	Daily assessment of herds needs
Risk of under-grazing or over-grazing	Daily assessment of grass supply
Doesn't allow for changing herd	Daily movement of temporary fence
Fertiliser spreading, topping/cutting & reseeding more difficult	More water troughs required to allow flexibility
Less paddock access points	Difficult to manage calves

Water System
A good water supply is extremely important for production, health and welfare of livestock. The water supply system must be good enough to supply adequate water needs in paddocks. On most farms the water system consists of a series of expansion or additions carried out over the years as requirements changed. Only when the system fails to cope, such as during a dry summer, do people realise how marginal their system has become. Common problems on most farms centre on inadequacies in areas such as, water source, pumping plant, pipe sizes, ballcocks and troughs.

Portable Water Troughs
It may be necessary to use portable water troughs in some situations e.g. strip grazing. To provide a portable trough, the use of frost-proof gate valves and good quality non-restrictive quick-couplers. Connection points should ideally be away from fixed troughs because they can be damaged and some valve types can be opened by stock, causing leaks.

2. Soil Fertility Management
Good productive soils are the foundation of any successful farming system and key for growing sufficient high quality grass to feed the herd. Therefore, the management of soil fertility levels should be a primary objective of every farm. However, nearly every farm assessed (irrespective of enterprise) in the competition have many soils that were below optimal soil fertility. This is reflective of the huge challenge the grazing industry faces.

A recent review of soils tested at Teagasc indicates that the majority of soils in Ireland are below the target levels for pH (i.e. 6.3) or P and K (i.e. Index 3) and will be very responsive to application of lime, P & K. On many farms sub-optimal soil fertility will lead to a drop in output and income if allowed to continue. Teagasc is highlighting 5 steps for effective soil fertility management.

1. Have soil analysis results for the whole farm
2. Apply lime as required to increase soil pH up to target pH for the crop
3. Aim to have soil test P and K in the target Index 3 in all fields
4. Use organic fertilisers as efficiently as possible
5. Make sure the fertilisers used are properly balanced

For those farmers aiming to improve soil fertility on their farms, following these 5 steps provides a solid basis for success.

Phosphorus (P)
The proportion of soils tested with low soil P fertility (i.e. P Index 1 and 2) has increased to approximately 62% in 2016. This overall trend reflects the soil P fertility status on dry-stock farms, and indicates a serious loss in potential productivity. Recent research has shown that soils with P index 3 will grow approximately 1.5 t DM/ha per year more grass than soils with P Index 1. Most of the DM yield response in these experiments took place in spring and early summer.

Potassium (K)
Soil analysis also shows that the trend in soil K status, across dairy and drystock enterprises, broadly mirrors that for P. Despite no legislative limits on K fertilisers, K usage dropped in line with P fertiliser applications. Consequently soil test results indicate a sharp increase in soils with low K status. Over half of the soil samples tested by Teagasc had very low to low soil K status (i.e. K Index 1 or 2) in 2016.

Increasing Soil Nutrient Availability-Lime
Lime is a soil conditioner and corrects soils acidity by neutralising the acids present and allowing the micro-organisms and earthworms to thrive and break down plant residues, animal manures and organic matter. This helps to release stored soil nutrients such as nitrogen (N) phosphorus (P) potassium (K) sulphur (S) and micro-nutrients for plant uptake. In addition, ryegrass and clover swards will persist for longer after reseeding where soil pH has been maintained close to the target levels through regular lime applications.

Liming acidic soils to correct soil pH will result in the following:

- Increased grass and crop production annually
- Increase the release of soil N by up to 60 units N/acre/year (75 kg N/ha)
- Increase the availability of soil P and K and micronutrients
- Increase the response to freshly applied N, P & K as either manures or fertiliser

When soil pH is low (more acid pH <6.0), grass yields may be reduced or reseeds may fail due to high levels of aluminium (Al) and manganese (Mn) interfering with root growth and nutrient uptake. On mineral soil types a target soil pH of 6.3 is recommended for grassland. Peat soils have lower quantities of Al and Mn present and therefore the target soil pH required is lower at pH 5.5. With the majority of agricultural soils nationally at low soil pH status the under application of lime is likely costing farmers dearly in terms of grass production and quality.

Ground limestone is the most cost effective source of lime and can be applied throughout the year when the opportunity arises. Lime is the foundation of soil fertility and is a primary step to take when correcting soil fertility.

3. Grazing Management

The optimum stocking rate for an individual farm is that which maximises profitability and is dependent on the individual farms grass growth capability. While every farm situation is unique with varying soil types, local climatic conditions, stocking rates and farmer management capabilities, many Irish farms are only producing 50% of their grass growth capability and therefore, grass production is limiting output on most farms. Large increases in grass production can be achieved. Increases in beef output production must come from utilising more grass and not from importing supplementary feed. In many respects, beef farmers need to up-skill themselves on grazing management practices, measuring pasture covers regularly (at least weekly during the main grazing season) making grazing decisions using grassland software and analysing their grassland production data. These are the key drivers of increasing the grass growth capacity on the farm.

PastureBase Ireland: Technologies to assist grassland management

It is argued that technologies which enable data-informed decision-making on the farm can help to increase farmers' confidence and greatly improve grassland management (Hanrahan *et al*., 2017). Huge leaps have been made in developing decision support tools to improve resource farm efficiency, profitability and sustainability. The primary objective of most of these tools is to increase the information available to assist in farm-management decision making, as well as to collect and collate large amounts of data in a centralised database (Hanrahan *et al*., 2017). Teagasc launched PastureBase Ireland (PBI) – an online grassland management decision support tool – in January 2013 and Grass10 will see the roll-out of the new PastureBase Ireland website as a key component of the campaign. Upon entering data from their own farm (e.g. grass measurements), the PastureBase Ireland platform provides real-time and customised grassland management advice to the farmer to assist their decision-making. These reports are developed in such a way that allows farmers to benchmark their individual farm with farms in their discussion group or in their region. The data accumulated to date indicates that PBI participating farms have achieved improvements in grass DM production and grazing management.

PastureBase Ireland is informing us that farmers need to have a good control of current grass supply in order to manage grass well. Grass cannot be managed correctly without knowledge of farm cover, grass demand and grass growth. The crucial point on any farm is utilising the feed resource produced on the farm. Any farm that is dependent on imported feed is exposed in the current volatile market environment.

Grassland performance on drystock farms.

The average annual grass DM production on drystock farms is around 12 t DM/ha over the last few years recorded on PastureBase Ireland (PBI). Competition farms grew 13t DM/ha on average over the last 2 years from PastureBase Ireland (PBI) analysis. Taking a more in-depth look at why some farms are able to produce high quantities of grass, it is clear that achieving more grazings from each paddock during the season is key driver of success.

The average number of grazings achieved per paddock/year on drystock farms is around 5. However the competition farms achieved 6. This results in more grass grown and utilised.

On a high proportion of drystock farms the number of paddocks is inadequate leading to a small number of large paddocks. The net result of this approach is long residency times (up to two weeks) and the productivity of these paddocks can be significantly reduced. A number of issues arise in these situations, regrowths are continually being regrazed, proper grazing heights are not achieved, nitrogen application is irregular and in many cases pre-grazing yields are too high, which results in swards needing to be topped on a number of occasions across the season.

There is a strong relationship between the number of paddocks per farm and the total number of grazings achieved per farm. PastureBase Ireland data has identified that the advantage of creating one new paddock on a farm will give five extra grazings from the farm annually. The creation of additional paddocks makes management of pasture more streamlined and leads to better control of grass, especially during periods of high growth. A key finding from the grazing performance of drystock farms recording on PBI showed the greater the number of grazings achieved, the higher the grass DM production produced. Every extra grazing achieved increased annual grass DM production by 1.5 t DM/ha.

Maximising the number of grazings achieved on each paddock is a very effective method of increasing farm grass utilisation. Paddock residency should be no longer than three or four days on drystock farms during the mid-season. It is critical that all drystock farms sub-divide existing paddocks into smaller areas with three or four day residency time. So grow the grass in 3 weeks and graze it in 3 days.

The role of Stakeholders

Significant change is required in the grassland management practices of Irish livestock farmers to ensure that Irish grassland farming systems remain competitive and sustainable. Teagasc recognises that the co-operation and collaboration of a range of organisations and stakeholders is required to achieve the changes required right across the industry. Teagasc on its own cannot achieve the scale of change required i.e. to shift the national figure for grass utilisation. Including relevant stakeholders will be part of the Grass10 campaign. This approach will also ensure that the messages from the campaign, and the support offered by those involved, will have a greater reach. So one of the ambitions of the Grass10 campaign is to formalise the relationships between Teagasc and other stakeholders, to ensure that consistent messages are delivered across the industry. Also, to ensure farmers are supported by all industry partners in the adoption of agreed best practices in grassland management.

Grass10 wishes to acknowledge the support of our industry stakeholders in this new campaign.

Effect of breed type and post-weaning plane of nutrition on age at puberty and pregnancy rate in beef heifers

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Introduction

In Ireland, there are approximately 1m beef suckler cows of which, about 85% are spring-calving, which reflects our seasonal grass-based systems of production. Traditionally, heifers selected as replacements for the national suckler cow herd were the progeny of early-maturing British beef breed bulls (e.g. Angus, Hereford, Shorthorn) mated to Friesian cows but progressively, bulls of late-maturing "continental" breeds (e.g. Charolais, Limousin) have predominated the breeding of both cows and bulls in the suckler herd (McGee, 2012). Currently, approximately 70% of the suckler cow herd and about 80% of the calves born are sired by late-maturing breeds (AIMS, 2016). Average annual replacement rate for the suckler herd is ca. 18% (ICBF, 2016). About 25% of replacement beef heifers are sourced from the dairy herd (beef × Holstein-Friesian) with the remainder sourced from the suckler herd, either homebred or purchased (McGee, 2012).

Puberty and age at first calving

Reproductive efficiency is a major determinant of production and profitability of beef suckler cow enterprises. Central to this is the age and the timing of puberty, an event which marks the commencement of a heifer's potential productive life within the herd. This is particularly important when heifers are bred to calve at 24 months of age and in production systems that impose restricted breeding periods, such as in seasonal calving herds. Indeed, research has shown that those beef heifers that calve for the first time at 24 months of age, and indeed within the first 21 days of the calving season, have greater longevity and profit per cow (Cushman *et al*., 2013, Day and Nogueira, 2013). Additionally, recent studies at Teagasc, Grange, have shown that for spring-calving grass-based systems, delaying age at first calving from 24 to 36 months of age decreased net margin per hectare by 50%. However, according to the ICBF, in 2016 less than 20% of beef heifers calved for the first time between the ages of 22 to 26 months with an average age of 31.5 months at first calving recorded. This has contributed to a large annual inventory of unproductive breeding cattle and provides major scope to improve the efficiency and profitability of the national beef suckler cow herd through improvements in replacement beef heifer reproductive performance.

Replacement heifers should reach puberty at least 21 days prior to the start of the breeding season and preferably, have undergone a number of oestrous cycles ahead of the breeding season given the reported lower conception rate at first oestrous (heat) in comparison to subsequent heats (Perry, 2016). The importance of early puberty is even greater where producers aim to breed heifers 3 to 4 weeks before the mature cows, mainly due to the typically longer post-partum interval experienced by first-calvers. With this in mind, heifers must become pubertal before 13 months of age in order to maximise the probability of achieving the target of calving for the first time at 24 months of age.

Reproductive traits, particularly age at first calving, can be improved through targeted genetic selection (McHugh *et al*., 2014). With accurate and reliable genetic evaluation more suitable sires and heifers/cows can be selected for breeding replacement heifers and thus, improve the reproductive efficiency of suckler beef production. However, this is a long-term solution and a more immediate management strategy is required to advance the current age at first calving in the Irish beef cow herd. It is widely accepted that nutrition during rearing plays an important role in reducing the age at which puberty occurs in beef heifers (Funston *et al*., 2012, Perry, 2016).

Age at puberty in beef heifers is dependent on body weight and age, and varies between individual breeds (Perry, 2016). In general, puberty is earlier in breeds selected for milk production and in early-maturing compared to late-maturing beef breeds (Van Eenennaam, 2013). North American studies suggest recommended target weights for replacement beef heifers at puberty (pre-breeding) of ca. 60% and at first breeding, ca. 65% of estimated mature body-weight (Perry, 2016). In Ireland, the historical switch in breed use, from early- to late-maturing breeds, coupled with the (past) emphasis on genetic selection for growth and carcass traits within our beef breeding programs, means that, theoretically, the age and weight at puberty of replacement heifers sourced from within the suckler herd may be increasing. Simultaneously, sourcing cow replacements from within the suckler herd rather than from the dairy herd has resulted in a reduction in proportion of dairy ancestry in cows and consequently, reduced milk yield and calf weaning weight (McGee *et al*., 2005). This likely divergence in heifer weight at weaning and age and weight at puberty exacerbates the challenge of achieving target weights at breeding for beef heifers.

Presently, there is no information on age at puberty in heifers of the different breed-types typically used as replacement heifers in Ireland. Furthermore, there is a lack of information on target weights at 12-13 months of age that ensure that puberty has occurred in advance of the breeding season. Additionally, there are no reliable data quantifying the mature weight of the main beef cow breeds in Ireland and therefore, inadequate data which to base mature weight-associated thresholds. In this context, a target weight (kg) at breeding rather than a 'mature weight percentage' is a more appropriate approach to replacement heifer development.

Conventional feeding practices for the first winter for 8-9 month old weanling cattle target moderate growth rates (0.5-0.6 kg/day) in order to exploit subsequent compensatory growth at pasture (Drennan and McGee, 2009). Considering that live weight of some Irish beef cow breeds exceed 700 kg (McGee *et al*., 2005), achieving recommended target weights to coincide with a restricted breeding season is often not possible through conventional feeding practices. Numerous studies have reported a reduction in age at puberty following enhanced growth rates post 8 months of age (Funston *et al*., 2012). However, it remains unclear what the optimum growth rate and the appropriate nutritional regime post 8 months of age that is required for replacement beef heifers to reach threshold weights for puberty attainment.

In summary, information is required regarding; the age at which puberty can be expected to occur for different breed types, what pre-breeding target weights are appropriate for these breed-types and to what extent can nutrition during the first winter be used to increase the number of heifers that reach puberty before the breeding season and the effect of all of these factors on subsequent pregnancy rates. This is of particular importance, within the context of a seasonal grass-based production system.

Therefore, the objectives of this study were to; establish the age at puberty in heifers of different breed types, establish breed type specific target weights at 12 months of age to ensure puberty and early conception and to identify breed type specific growth rates and appropriate nutritional regimes for replacement heifers to reach threshold weights.

Experiment details

A two-year study (2015 and 2016), funded by the Department of Agriculture, Food and the Marine, was carried out at Teagasc, Grange Beef Research Centre using a total of 311 spring-born early- (Angus; EM) and late- (Limousin; LM) maturing breed heifers born to dams of either suckler beef (Beef suckler-bred - B) or dairy (Dairy-bred; D) cows. Heifers were sourced from commercial farms using herd and genetic information available through the Irish Cattle Breeding Federation (ICBF), and were assembled at Grange in October/November each year. Upon arrival at the research centre, all animals were vaccinated as a prophylactic measure against respiratory disease and treated for the control of ecto- and endo-parasites. Following arrival and prior to housing, all heifers were rotationally grazed at pasture and managed similarly.

Heifers were then housed in pens (5 animals per pen) in a slatted-floor shed and assigned to one of two dietary nutrition levels over the indoor winter period; 1) grass silage to appetite (69% dry matter digestibility - DMD) and 1.5 kg of a barley-based concentrate daily in order to achieve a target ADG of 0.50 kg (**MOD**) or, 2) concentrate and grass silage to appetite in order to achieve a target ADG of >1.00 kg (**HI**). The duration of this indoor feeding period was from 17 November to 7 April (141 d) and 16 November until 15 April (150 d) in years 1 and 2 of the study, respectively.

Heifers were turned out to pasture on 7 April in year 1 and on 15 April in year 2 of the study. At pasture they were rotationally grazed in six groups, balanced for breed type and winter dietary treatment, on perennial ryegrass dominant swards. Breeding commenced on the 27 and 25 of April, and finished on 18 July and 20 July in years 1 and 2 of the study, respectively. Detection of oestrus was carried out 4 times daily for 20 minutes on each occasion by trained personnel. To facilitate heat detection, a vasectomised bull fitted with a chin-ball and harness, and Estrotect Heat Detector patches (Rockway Inc., Spring Valley, WI) or tail-paint were also used. All heifers were artificially inseminated (AI) by the same professional technician in both years in accordance to the AM:PM rule and using semen from a single highly fertile sire. Pregnancy scanning was carried out 30-40 days after AI using transrectal ovarian and uterine ultrasonography with an Ibex Pro ultrasound device (E.I. medical imaging, Colorado, USA) equipped with an L6.2 8-5MHz multi-frequency transducer. When confirmed in-calf, heifers were removed from the study.

Heifers were weighed on consecutive days at the beginning of the experiment, weekly during the indoor feeding period and fortnightly at pasture until removal from the study. Blood was sampled using jugular venepuncture every Monday and Thursday throughout the experiment, to determine the onset of puberty, based on plasma progesterone concentrations.

Results

Dry matter intake (DMI) during the indoor winter feeding period is presented in Table 1. Overall, there was no difference in daily silage, concentrate or total DMI per animal between Dairy-bred and Beef suckler-bred heifers. Heifers from early-maturing breed sires had a higher daily DMI of concentrate and grass-silage than heifers from late-maturing breed sires. By design, heifers on the HI diet had a higher DMI of concentrates (5.5 vs. 1.1 kg/d) and total DMI (7.0 vs. 4.9 kg/d) than heifers on MOD diet, while MOD heifers had a higher total DMI of silage (3.8 vs. 2.0 kg/d) than those on the HI diet.

Key growth-related data for the winter period are shown in Table 2. Compared to Dairy-bred heifers, Beef suckler-bred heifers were 79, 61 and 57 kg heavier at the beginning of the winter period, at 12 months of age and at the end of the winter period. This latter weight difference (57 kg) persisted through to puberty, the onset of the breeding season, first AI and conception. Heifers from dairy dams had a greater ADG (0.84 vs. 0.70 kg) during the winter period than heifers from beef suckler dams. Heifers from late-maturing breed sires were heavier at puberty (+18 kg) than those from early-maturing breed sires with no significant difference detected in live-weight at any other time-point. As expected, heifers on the HI diet over the indoor winter period had a greater ADG (+0.5 kg/day) than those on the MOD diet and were 56, 69, 53, 29, 34 and 34 kg heavier at 12 months of age, at the end of winter, the onset of the breeding season, puberty, first AI and at conception, respectively.

Heifer reproductive performance is presented in Table 3. There was a significant nutrition × sire breed interaction for the percentage of heifers that were pubertal at the onset of the breeding season. Nutrition level over the indoor winter had a much greater effect on the percentage of heifers pubertal at the onset of the breeding season for LM (MOD = 4% vs. HI = 27%) compared to EM (MOD = 23% vs. HI = 34%). There was evidence that the effect of nutrition was not consistent across dam source. Nutrition had no effect on age at first AI for Dairy-bred heifers (MOD = 445 vs. HI = 443 kg), whereas for the Beef suckler-bred heifers, those offered the HI diet were 10 days younger at first AI than those offered the MOD diet.

Overall, there was no difference between Dairy-bred and Beef suckler-bred heifers in age at puberty or percentage pubertal at the onset of the breeding season. However, 6-week submission rate was greater for Dairy-bred heifers than Beef suckler-bred heifers. There was a tendency for a greater 6-week conception rate in Dairy-bred than Beef suckler-bred heifers, whereas Dairy-bred had a greater 6-week pregnancy rate than Beef suckler-bred heifers. Despite no difference in 12-week submission rate for Beef suckler-bred and Dairy-bred heifers, Dairy-bred heifers had a greater 12-week pregnancy rate than Beef suckler-bred heifers.

Heifers sired by LM bulls were 15 days older at puberty than heifers sired by EM bulls, regardless of dam breed or overwintering diet offered. Despite this and the fact that LM heifers were also 15 days older at the time of first AI, there was no difference in either 6-week or 12-week submission rate between EM and LM heifers. Notwithstanding this, 6-week pregnancy rate was 15% greater for EM heifers compared to LM heifers. However, there was no difference in pregnancy rate following 12 weeks of breeding between EM and LM breeds.

Overall, heifers offered the HI diet were 13 days younger at puberty and had a greater 6-week submission rate than those offered the MOD diet. However; there was no difference in 6-week or 12-week pregnancy rate between the two nutrition levels.

Conclusion

Overall, dam source had no effect on age at puberty, the number of heifers pubertal at the beginning of the breeding season or age at first AI. Pregnancy rate at 6 weeks and at 12 weeks was higher for Dairy-bred compared to Beef suckler-bred heifers. Heifers sired by early-maturing breeds were younger at puberty and at first AI than those sired by late-maturing breeds. Pregnancy rate at 6 weeks was higher for early-maturing than late-maturing breed heifers but there was no difference in pregnancy rate between the sire breeds at 12 weeks. Age at puberty was younger for HI heifers than MOD heifers. The HI diet increased the number of heifers pubertal at the beginning of the breeding season for late-maturing sired heifers but not early-maturing sired heifers. Age at first AI was younger for HI than MOD heifers but there was no difference in pregnancy rate at 6 or 12 weeks between HI and MOD heifers.

Table 1: Feed dry matter intake (DMI) of heifers during the indoor winter feeding period

	Dam Breed (DB)		Sire Breed (SB)		Nutrition (N)		Significance		
kg DMI/head/day	**D**	**B**	**EM**	**LM**	**MOD**	**HI**	**DB**	**SB**	**N**
Concentrate	3.3	3.3	3.4	3.2	1.1	5.5	ns	***	***
Grass silage	2.7	2.7	2.8	2.6	3.8	2.0	ns	***	***
Total	6.0	6.0	6.2	5.8	4.9	7.0	ns	***	***

Table 2: Mean live-weights of heifers from housing to conception and average daily live-weight gain (ADG) over the indoor winter period

	Dam Breed (DB)		Sire Breed (SB)		Nutrition (N)		Significance			Interaction
	D	**B**	**EM**	**LM**	**MOD**	**HI**	**DB**	**SB**	**N**	
Live-weight (kg)										
Housing	217	296	250	262	256	257	***	ns	ns	***1
12 months of age	311	372	337	346	313	369	***	ns	***	*2
End of winter	337	394	362	370	331	400	***	ns	***	
Breeding	330	387	354	363	332	385	***	ns	***	
Puberty	347	403	366	384	360	389	***	**	***	*3
1st AI	356	411	379	389	367	401	***	ns	***	
Conception	366	422	389	399	377	411	***	ns	***	
ADG winter period	0.84	0.70	0.78	0.76	0.51	1.03	***	ns	***	

1 DB x SB means were 220 v 213 and 280 v 311 kg for EM v LM for D and B, respectively
2 DB x SB means were 314 v 308 and 360 v 384 kg for EM v LM for D and B, respectively
3 DB x SB means were 341 v 353 and 390 v 415 kg for EM v LM for D and B, respectively

Table 3: Heifer reproductive performance

	Dam Breed (DB)		Sire Breed (SB)		Nutrition (N)		Significance			Interaction
	D	B	EM	LM	MOD	HI	DB	SB	N	
Age at puberty, d	429	432	423	438	437	424	ns	***	***	
Pubertal heifers (%)	16	19	28	11	9	31	ns	***	***	SB x N*[1]
Age at 1st AI, d	443	445	423	438	447	441	ns	***	**	SB x N*[2]
6 week submission (%)	90	82	88	84	79	91	*	ns	**	
6 week pregnancy (%)	65	52	66	51	56	61	*	**	ns	
6 week conception (%)	75	64	75	63	71	68	0.06	*	ns	
12 week submission (%)	100	100	100	100	100	100	ns	ns	ns	
12 week pregnancy (%)	93	83	89	89	91	87	**	ns	ns	

[1] SB × N means were 23% v 34% and 3.5% v 27% MOD v HI, for EM and LM respectively
[2] SB × N means were 445 v 443 and 451 v 441 MOD v HI, for EM and LM respectively

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How can genetics play a role in a profitable dairy beef system?

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Summary

- The use of beef genetics on the dairy herd is increasing each year
- Angus, Hereford and Limousin are the most popular beef breeds
- Choosing a beef bull based on its terminal traits is important for optimising farm profit for both dairy and beef farmers
- A sire evaluation trial, in conjunction with ABP, is on-going to identify the most suitable beef genetics to cross with dairy herds
- The selection of calves from higher genetic merit sires leads to higher on farm performance and profitability

Introduction

The dairy beef sector in Ireland is an important and growing industry. Due to the growth in the national dairy cow population in the post-quota era (1.085 million in 2012 to 1.330 million in 2016 (AIMS, 2012; AIMS, 2016)), there has been a proportional increase in the number of dairy calves available for beef production. The use of breeding tools, such as the EBI, has increased the fertility of Irish dairy herds. Consequently, fewer cows are required to be bred to dairy bulls to produce heifer replacements, leading to an increase in the use of beef genetics (7% increase in the number of beef cross calves coming from the dairy herd from 2012 to 2016).

The contribution of the calf enterprise to the profit of the dairy farm is generally considered small; therefore beef bull selection on dairy farms is often not considered a high priority. A recent survey was carried out by Teagasc to investigate the criteria used by dairy farmers to select their beef bulls. Out of eight possible criteria, the survey found that easy calving, short gestation and breed were the most important traits used by dairy farmers.

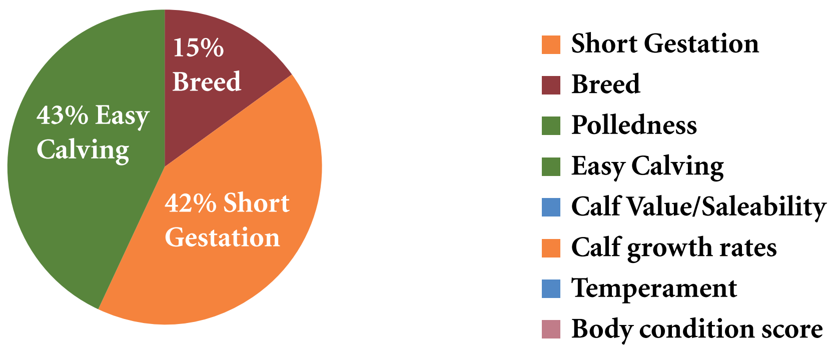

Figure 1. Traits valued 'most important' for beef sire selection on dairy herds

Results from this Teagasc survey found that 43% of farmers valued easy calving as the most important trait for selecting a beef bull. This was followed closely by short gestation (42%) and by breed (15%).

Calves from the dairy herd for beef production

Beef bulls are generally used on the dairy herd after sufficient dairy replacements have been sired. Currently, approximately 30% (398,000) of dairy calves born are replacement dairy heifers (AIM, 2016), leaving the remaining calves (900,000) available for beef production. Male dairy calves account for 45% of the these dairy beef calves, however out of the dairy beef calves born, early-maturing crossbred calves (male and female) account for a further 46%. Aberdeen Angus and Hereford are the most popular beef breeds used (45% and 30% of dairy beef calves, respectively), with Limousin sires accounting for a further 11% of the crossbred calves.

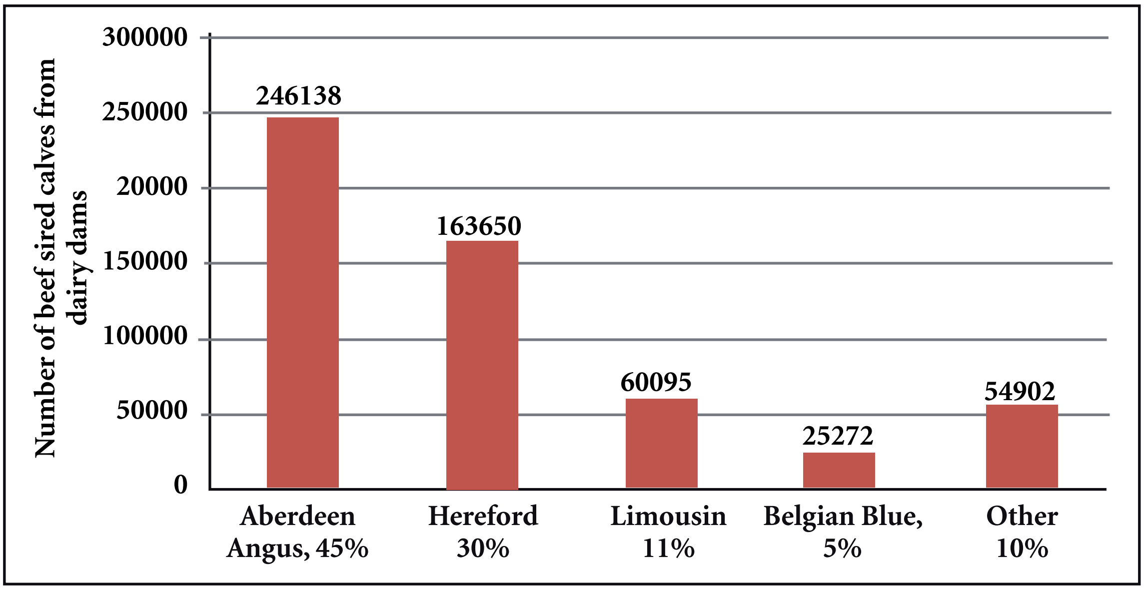

Figure 2. Beef sire selection for dairy dams (AIM, 2016).

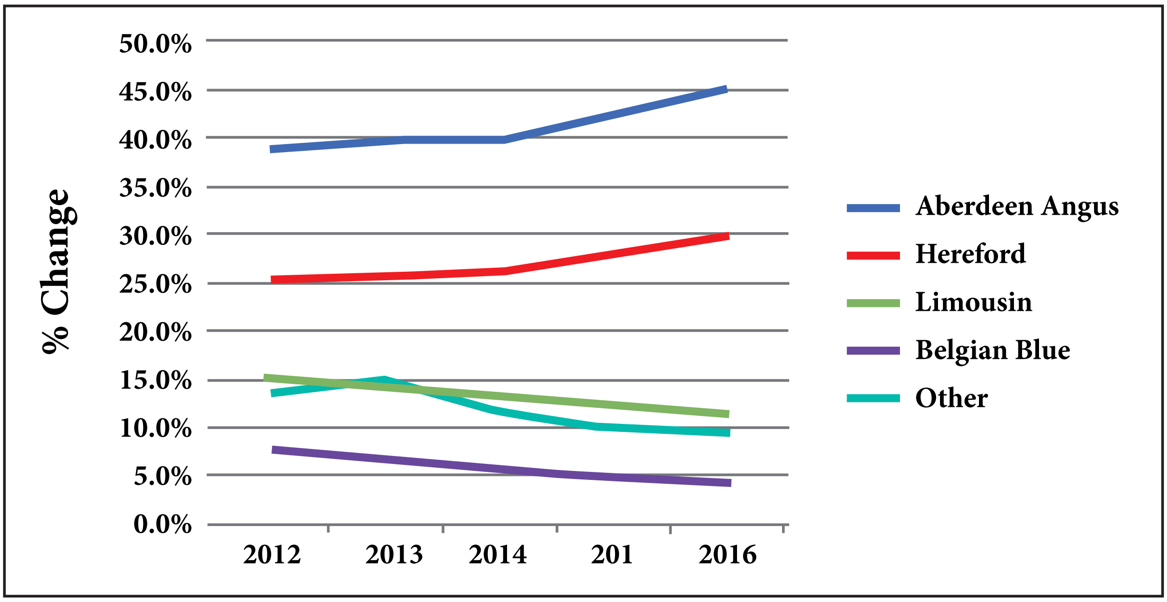

Figure 3. Percentage change in beef sire breeds being used on the dairy herd over the last five years (AIMS 2012-2016).

The Teagasc/ABP Dairy Beef Programme

The Teagasc/ABP Dairy Beef Programme began in 2014. For the first year, the main objective was to compare the performance of progeny from easy calving short gestation sires with average gestation sires using Angus, Hereford and Limousin bulls. In total, 600 calves were purchased for this trial. From 2015 the programme evolved into a sire evaluation trial in conjunction with the ICBF Gene Ireland Dairy Beef Programme. The programme identified two primary objectives: 1) to identify the most suitable beef bull genetics for crossing on dairy herds and 2) to genetically improve the main breeds supplying beef bulls to the dairy herd.

As part of the programme, beef sires are identified each year and distributed to interested dairy farmers. Calves are purchased directly from farms at two to four weeks of age. These producers receive a €25/calf bonus payment over the market value as recompense to farmers for using trial semen, meeting the required health standards and for recording the requested data. The 600 calves are reared through the ABP Blade Programme. At 15 weeks of age, 350 calves are moved onto the ABP trial farm in Carlow until slaughter, while 250 are purchased by Teagasc and finished at Johnstown Castle, Co. Wexford. Animal performance is measured throughout the production cycle. Meat quality evaluations are made through collaboration with Meat Technology Ireland.

Results Teagasc/ABP Dairy Beef Programme 2015

Overall, the heifer and steer progeny achieved average carcass weights of 264 kg and 325 kg at 19 and 21 months of age, respectively. Both steers and heifers averaged O= for conformation and 3= for fat, meaning they were within the specifications for the QAS and breed bonuses (Table 1).

The results to date show large variations in progeny performance between individual sires for key economic carcass traits. For example, the Angus progeny from FPI had 53kg heavier carcasses, with a 1% higher kill-out percentage than JYK (Table 2). Similarly, progeny from the Hereford bull DPS had 52kg heavier carcasses than TGB (Table 3).

Performance results from the ICBF centre in Tully (Figure 5) show clear differences in feed conversion efficiencies between sires. Progeny from the sire RGZ consumed 1.94kg less feed for every kilogram of live weight gain than progeny from ZTP. Progeny from RGZ had a 0.39kg/day higher average daily gain over the 77 days of finishing compared to progeny from ZTP. These results clearly demonstrate the importance of measuring feed efficiency in a breeding programme in order to identify sires that produce highly feed efficient animals for beef farmers.

Table 1: Mean carcass weight (Cwt), conformation (Conf), fat (Fat), age (Age) and kill-out percentage (KO%) for early maturing heifers and steers.

	Cwt (kg)	Conf (1-15)	Fat (1-15)	Age (mths)	KO %
Heifers	264	5.25 (O=)	6.93 (3=)	19.33	49.57
Steers	325	5.92 (O=)	6.63 (3=)	21.31	50.59

Table 2: The effect of Angus sire on carcass weight (Cwt), carcass conformation (Conf), carcass fat (Cfat) and kill-out %.

Sire	Breed	Cwt (kg)	Conf (1-15)	Fat (1-15)	Kill-out (%)
JYK	AA	271	5.8 (O=)	7.4 (3+)	50.0
ZTP	AA	281	6.0 (O+)	7.8 (3+)	50.4
LZE	AA	287	5.6 (O=)	6.0 (3=)	50.0
YRE	AA	296	5.6 (O=)	8.1(3+)	49.1
ZHF	AA	299	5.8 (O=)	6.8(3=)	49.5
MWG	AA	300	5.6 (O=)	7.0(3=)	49.5
KYA	AA	300	5.9 (O=)	7.3 (3+)	50.3
JGY	AA	301	6.0 (O+)	6.7(3=)	50.6
GJB	AA	305	5.1 (O=)	6.5 (3=)	50.8
RGZ	AA	309	6.2 (O+)	7.2 (3+)	50.3
FPI	AA	324	5.9 (O=)	6.8 (3=)	51.0

Table 3. The effect of Hereford sire on carcass weight (Cwt), carcass conformation (Conf), carcass fat (Cfat) and kill-out %.

Sire	Breed	Cwt (kg)	Conf (1-15)	Fat (1-15)	Kill-out (%)
TGB	HE	287	6.0 (O+)	7.4 (3+)	50.3
CRP	HE	293	5.6 (O=)	8.0 (3+)	49.4
KKO	HE	301	6.1(O+)	7.9 (3+)	51.0
CKVZ	HE	301	5.5 (O=)	7.8 (3+)	50.6
FRZ	HE	301	5.3 (O=)	7.4(3+)	49.6
SPL	HE	303	6.2 (O+)	6.7 (3=)	51.4
KHO	HE	306	5.4 (O=)	9.0 (4=)	50.5
S2150	HE	308	6.7 (O+)	7.2 (3+)	50.1
HWP	HE	310	5.0 (O=)	7.3(3+)	49.5
GZS	HE	311	6.4 (O+)	7.0 (3=)	50.3
GPZ	HE	315	6.4 (O+)	7.4 (3+)	51.5
LTX	HE	316	5.9 (O=)	7.5 (3+)	51.2
KNL	HE	318	5.3 (O=)	7.3 (3+)	51.1
S2122	HE	319	6.3(O+)	7.1 (3+)	51.1
GGA	HE	326	7.0 (R-)	7.9 (3+)	50.8
DPS	HE	339	6.6 (O+)	7.5 (3+)	49.9

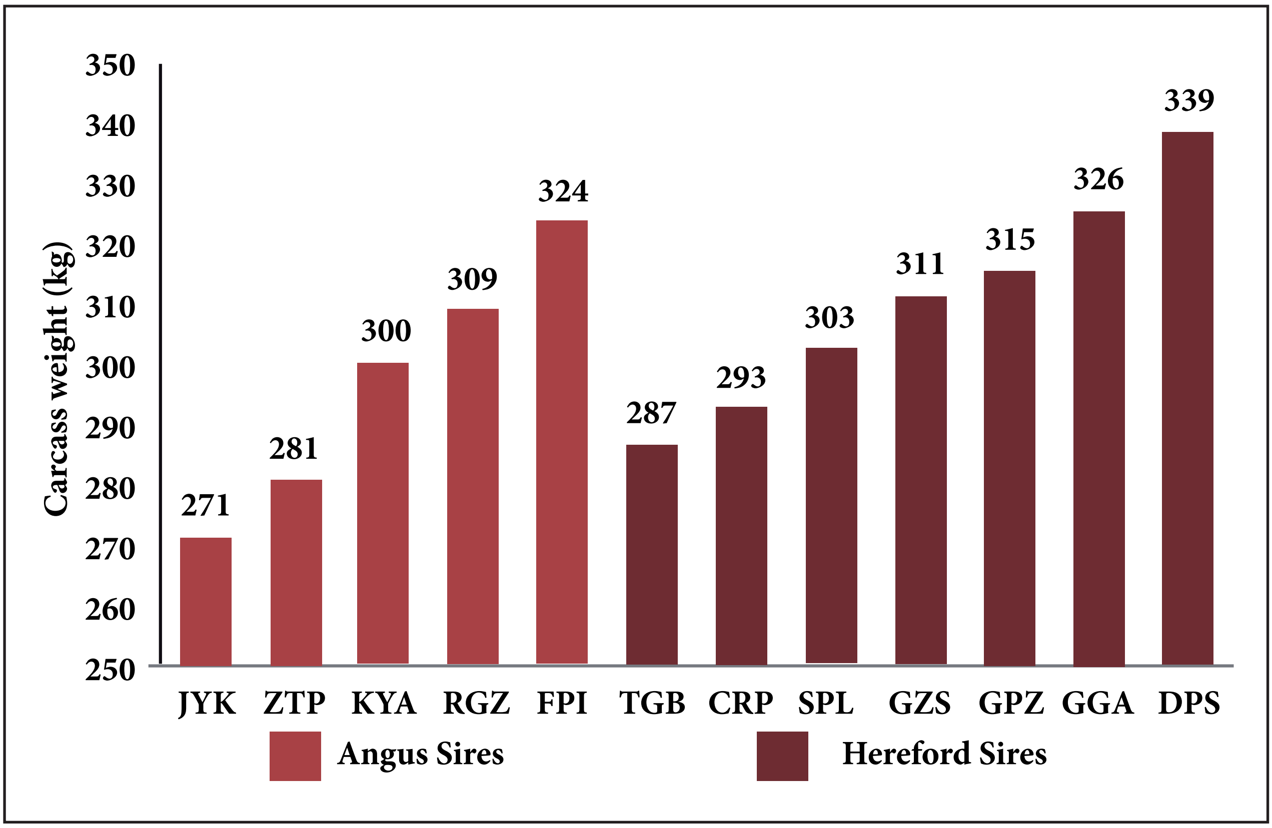

Figure 4. Variation in progeny carcass weight from different Angus and Hereford sires.

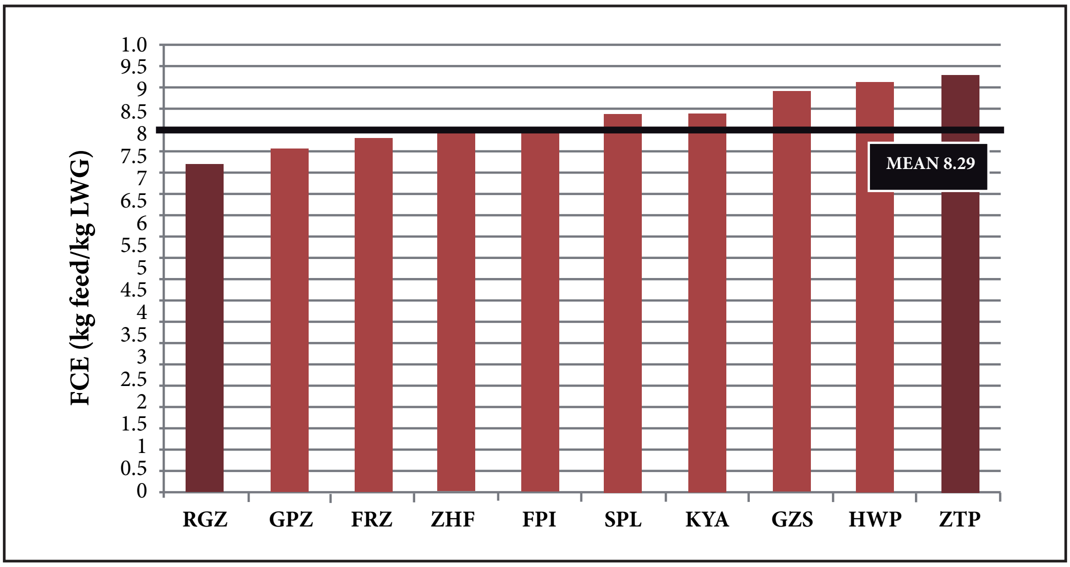

Figure 5. The effect of sire on feed efficiency (kg of feed per kilogram live weight gain) of steer progeny finished over 77 day period in ICBF performance testing unit, Tully.

The ICBF Dairy Beef Gene Ireland Programme

The Dairy Beef Gene Ireland programme was set up in 2015, in conjunction with Teagasc and Anglo Beef Processors (ABP). As part of the programme, unproven, short gestation and easy calving sires with high genetic merit for important terminal traits (determined using the Terminal index) are identified by ICBF, AI companies and breed societies for use in the programme. Participating dairy farmers purchase the semen at a reduced rate. In return, the farmers record traits such as calving difficulty, gestation length, calf quality and defects.

The ultimate aim is to identify bulls with the highest performance for carcass weight, conformation and feed intake for beef production, with high meat quality for the consumer without comprising calving difficulty or gestation length for the dairy cow. These high performing bulls can then be used to improve the genetic merit of the pedigree beef herds which, in turn, will produce the next generation of beef bulls for the dairy herd.

The programme has grown rapidly from its inception (Table 4). In 2015, 650 dairy farmers involved with the Gene Ireland Dairy Programme had the option of using beef straws from the Dairy Beef programme, however only 108 of these farmers participated. Since then, the number of dairy herds taking part in the programme has doubled, semen sales have increased by 4,550 doses and the number of bulls involved has grown from 12 to 19. In addition the number of breeds involved expanded from three in 2015 to six in 2017.

Table 4: Overview of the growth of the Gene Ireland dairy beef programme.

2015 Programme	2016 Programme	2017 Programme
2,750 straws	5,666 straws	7,300 straws
12 bulls- Angus, Hereford and Limousin	14 bulls- Angus, Hereford, Limousin and Shorthorn	19 bulls- Angus, Hereford, Limousin, Shorthorn, Saler and Belgian Blue
108 herds involved	166 herds involved	208 herds involved
1,400 inseminations	3,760 inseminations	3440 (to date)

The ICBF Terminal index

The terminal index is used to identify and rank beef animals based on their profitability for the entire production system. The sub-indexes that form this index include carcass weight, conformation, fat, docility, feed intake and calving difficulty.

Table 5: Sub-indexes of the terminal index and their economic weighting.

Trait	Emphasis (%)	Economic weighting (€)
Calving difficulty	18%	-4.65
Gestation	4%	-2.25
Mortality	3%	-5.34
Docility	2%	17.02
Feed intake	16%	-38.63
Carcass weight	40%	3.14
Carcass conformation	11%	14.77
Carcass fat	5%	-7.86

For beef farmers, the most important traits for profitable production are carcass weight, conformation and feed intake. Results from the Teagasc/ABP Dairy Beef Programme show that progeny from sires of higher genetic merit for carcass weight have heavier carcasses at slaughter. In addition, the difference between a steer having a conformation score of O= instead of O- can be worth almost €115 to a farmer (based on a 300 kg carcass and €0.20/kg breed bonus, meeting the quality assurance and breed bonus specifications and claiming €0.06 cent on the quality payment grid).

How can you ensure you purchase calves of high genetic merit?

The ICBF animal search bar on the ICBF website can be used to check the genetic merit of an AI bull or stock bull (**https://www.icbf.com/wp/).** Additionally, farmers can identify bulls by using the link to the Active Bull Lists and selecting the Terminal List under Beef. Bulls can be searched by breed, and searches can be filtered to suit the farmer's needs, i.e. by terminal index traits, carcass traits etc.

Communicating with local AI technicians can enable dairy beef producers to identify dairy herds that use high genetic merit terminal bulls. Another way to ensure the purchase of high genetic merit calves is to collaborate with dairy farmers, i.e. negotiate mating with specific bulls with buy back options. This would allow both enterprises to meet their requirements and potentially maximise their profit.

Conclusion

The growth of the national dairy herd is predicted to continue, therefore the dairy beef industry will continue to expand and gain importance. The use of bulls with higher genetic merit for beef traits can have a major impact on a dairy beef farmer's income through increased carcass sales, better carcass conformation, increased numbers of animals meeting the quality assurance and breed bonus specifications, shorter finishing periods and reduced feed costs. It is vital that beef farmers avoid selecting calves solely on their appearance at two to three weeks of age. Instead they should aim to purchase calves on their genetic merit and, by doing this, calves of low genetic merit for beef will eventually be penalised in the market.

The Gene Ireland dairy beef programme, in conjunction with Teagasc and ABP, can play a major role in improving the genetic merit of the beef bulls for use on the dairy herd. This will ultimately improve the value of calves from the dairy herd and the profitability of dairy beef production. However combined support is needed from all beef industry stakeholders, beef farmers, and the dairy industry.

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Concentrate feed ingredients for growing-finishing cattle

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Introduction

Beef producers are in the business of converting feed into animal product as cost efficiently as possible. Feed provision accounts for over 75% of direct costs of beef production (Finneran, *et al.*, 2012). Relative to concentrates or conserved forage diets, grazed grass is generally the cheapest feed source in grass-based farming systems and beef producers should aim to maximise animal output from grazed grass. Nevertheless, the main feed costs on beef farms occur during the indoor (winter) feeding periods, and especially feeding of finishing cattle. For example, within grass-based, suckler calf-to-steer beef systems on research farms, grazed grass, grass silage and concentrate account for 66%, 27% and 7% of feed dry matter (DM) intake annually, respectively. When this feed consumption is expressed in terms of cost (land charge included), the outcome is very different: grazed grass, silage and concentrate account for 44%, 39% and 17% of the total annual feed costs, respectively. This means that even small improvements in feed (cost) efficiency at these times has a relatively large influence on farm profitability. Economic sustainability of beef production systems therefore depends on optimising the contribution of grazed grass to the lifetime intake of feed, and on providing silage (O'Kiely, 2014) and concentrate as efficiently and at as low a cost as feasible.

Feeding concentrates: Key principles

Feeding concentrates is a key component of beef production systems, especially during the indoor winter period and the finishing period. The primary role of concentrates is to make up the deficit in nutrient supply from forages to allow cattle reach performance targets. Comparisons of feedstuffs should always be based on their net energy (and protein) values on a DM basis. It is important to ensure that adequate levels of an appropriate mineral/vitamin mix are included in the concentrate ration.

Dry matter digestibility (DMD) is the primary factor influencing the 'quality' or nutritive value of forage and consequently, the performance of cattle. Low DMD forage requires higher levels of concentrate supplementation to achieve the same growth rates or performance of cattle (Table 1). Increasing the level of concentrates in the diet reduces forage intake (substitution rate) and increases live weight and carcass weight gains, although at a diminishing rate. The production response to concentrate supplementation is higher with forages of lower DMD and in high-growth potential animals. Increasing concentrate supplementation reduces the importance of forage nutritional value, especially so when feeding concentrates *ad libitum* (to appetite). The optimal level of concentrate supplementation to achieve target growth primarily depends on animal production response (kg gain/kg concentrate), forage substitution rate and the relative prices of animal product and feedstuffs (McGee, 2015).

Concentrate feeding indoors

Weanling cattle:

The optimum winter growth rate for weanling cattle destined to return to pasture for a second grazing season is about 0.5-0.7kg live-weight daily. These animals will subsequently avail of compensatory growth on low-cost grazed grass (McGee *et al.*, 2014). This target growth rate can be achieved on grass silage supplemented with concentrates as outlined in Table 1.

Finishing cattle:

Efficiency of feed utilisation by finishing cattle primarily depends on weight of animal (decreases as live weight increases), potential for carcass growth (e.g. breed type, gender, compensatory growth potential) and duration of finishing period (decreases as length increases) (McGee, 2015). High quality grass silage alone will not supply sufficient nutrients to sustain adequate growth rates to exploit the growth potential of most cattle, so concentrate supplementation is required. Each 1 unit decline in DMD of grass silage requires an additional ca. 0.33 kg concentrate fresh weight daily to sustain performance in finishing cattle. For example, concentrate supplementation rates for finishing steers to achieve ca. 1.0 kg live weight/day with grass silage varying in DMD are shown in Table 1. Correspondingly, for finishing heifers (lower growth potential) daily supplementation is reduced by about 1.5 to 2.0 kg and for finishing bulls (higher growth potential) rates should be increased by about 1.5 to 2.0 kg.

Where grass silage DMD is poor (e.g. 60%) and/or silage is in short supply, and animal growth potential is high, feeding concentrates *ad libitum* should be considered. However, when feeding concentrates *ad libitum,* particularly cereals, there is a risk of acidosis. Therefore, it is critical to ensure; (i) gradual adaptation to concentrates, (ii) minimum roughage inclusion (~10% of total DM intake) for rumen function, (iii) meal supply never runs out and, (iv) a constant supply of fresh water is provided.

Table 1: Concentrate supplementation (kg/day) necessary for weanlings to grow at ~0.5 kg and for finishing steers (600 kg) to grow at ~1.0 kg live weight/day, when offered grass silage of varying dry matter digestibility (DMD) to appetite

Grass Silage DMD (%)	**~60**	**~65**	**~70**	**~75**
Weanling heifers and steers	2.0-3.0	1.5-2.0	1.0-1.5	0-1.0
Finishing steers	-	7.0-8.0	5.5-6.5	4.0-5.0

Concentrate feed ingredients

Energy is the most important nutrient required by growing-finishing cattle. In addition to cereals, a wide variety of feed ingredients is available and used extensively in beef rations. Indoor feed costs could be reduced through utilisation of alternative (more cost-effective) feed ingredients.

By-product feeds, also known as co-products, are secondary products mainly from the food processing industry and the biofuel/ethanol industry. By-products generally have little value as a foodstuff for humans, but many are suitable as a feed for cattle due to the ability of cattle to digest fibrous, plant cell-wall material. However, a potential limitation of feeding by-products to cattle is that significant variation can exist in their chemical composition and nutrient content, and this is liable to change over time as the primary manufacturing processes evolve and become more efficient. This means that periodic re-evaluation of the nutritive value of by-products is required for accurate formulation of feedstuffs for beef cattle.

In this context, a series of recent experiments carried out at Teagasc Grange, funded by the Department of Agriculture, Food and the Marine (DAFM), have evaluated a number of key by-product feed ingredients in beef cattle diets.

Supplementing grass silage for growing cattle - weanlings:

Soya hulls* and *Citrus pulp

Soya hulls is a by-product obtained during the dehulling of soya beans; Dried citrus pulp is a by-product obtained following the pressing of citrus fruits (e.g. oranges, grapefruits) during the production of citrus juice. In two experiments the effects of replacing rolled barley (i.e., starch-based feed) with soya hulls (Exp. 1) or citrus pulp (Exp. 2); (i.e., digestible fibre-based feed) in a concentrate supplement on intake and performance of young growing suckler-bred male weanling cattle offered grass silage to appetite were examined (Table 2).

In Experiment 1, cattle were offered 1.7 kg DM once daily of either a Barley/soyabean-based (862g rolled barley, 60g soya bean meal, 50g molasses, 28g minerals and vitamins/kg) or a Soya hulls-based (933g soya hulls; 50g molasses; 17g minerals and vitamins/kg) supplement. In Experiment 2, cattle were offered 1.6 kg DM daily of either a Barley/soyabean-based (same formulation as above) or a Citrus pulp-based (855g citrus pulp, 80g soya bean meal, 53g molasses, 12g minerals and vitamins /kg) supplement. Concentrates were prepared as coarse mixtures and formulated to have similar concentrations of true protein digestible in the small intestine on a DM basis. Concentrate supplement type did not significantly affect daily grass silage intake, live-weight gain, final live weight, ultrasonically assessed body composition or measurements of skeletal size.

In conclusion, at the levels of supplementation used in these experiments, soya hulls and citrus pulp can replace barley in concentrate supplements for growing cattle offered grass silage, without negatively affecting performance.

Table 2: Effect of supplementary concentrate type on grass silage dry matter (DM) intake, daily live weight gain (ADG) and feed conversion ratio (FCR) of suckler-bred male cattle

	Experiment 1			**Experiment 2**		
	Barley/ soyabean	**Soya hulls**	Sig.	Barley/ soyabean	**Citrus pulp**	Sig.
Final weight (kg)	488	489	NS	453	450	NS
ADG (kg)	0.862	0.875	NS	0.685	0.656	NS
DM intake (kg/day)	5.28	5.30	NS	4.40	4.49	NS
FCR (kg DM/kg ADG)	6.17	6.17	NS	6.64	6.99	NS

Source: Lenehan *et al*. 2015a and 2017 – Teagasc Grange

Concentrate feeds for growing-finishing cattle:

Dried distillers grains

Dried distillers grains, a by-product of the distillation process, is the residual product following the sequential milling, fermentation, and removal of water from cereal grains. Intake and performance of beef cattle offered a barley-based ration with increasing levels of inclusion of maize or wheat dried distillers grains as a supplement to grass silage ('growing phase') and, subsequently, to appetite ('finishing phase') were evaluated (Tables 3 and 4). The concentrates assessed were: a barley-soya 'control' ration (862g/kg rolled barley, 60g/kg soya bean meal, 50g/kg molasses and 28g/kg minerals and vitamins), and barley-soya based rations where the barley (plus all soya bean meal) was replaced with 200, 400, 600 and 800g fresh weight maize dried distillers or wheat dried distillers grains/kg. Concentrates were prepared as coarse mixtures. Steers were individually offered 3.0 kg DM of the respective concentrates as a supplement to moderate digestibility grass silage offered to appetite over a 70-day growing phase and, following a 26-day dietary adaptation period, were offered the same concentrates *ad libitum* plus 3kg fresh weight grass silage during an 86-day finishing phase.

Results showed that maize dried distillers grains had a superior feeding value (based on dietary feed conversion ratio) to wheat dried distillers grains at both concentrate feeding situations. Both maize and wheat dried distillers grains had a superior feeding value compared to the barley-soya based control ration when offered as a supplement to growing cattle; however, this superiority was not evident when the concentrate was offered to appetite.

Under the conditions of this study, results indicated that the optimal inclusion level of maize and wheat dried distillers grains in the concentrate was about 800g/kg when the concentrate ration was offered as a supplement to grass silage and, about 400g/kg for maize, and 200g/kg for wheat, dried distillers when the ration was offered *ad libitum*.

In summary, the feeding value of dried distillers grains was a function of their inclusion level in the concentrate and whether the concentrate was offered as a supplement to grass silage or offered to appetite with restricted grass silage.

Table 3: Effects of inclusion level of maize dried distillers grains in a barley-soya based concentrate on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of steers.

	Maize distillers inclusion level (g/kg)					Sig.[1]
	0	200	400	600	800	
Growing Phase						
ADG (kg)	0.87	1.11	1.19	1.17	1.33	L
DM intake (kg/day)	6.9	6.9	6.9	6.7	6.7	NS
FCR (kg DM/ kg ADG)	8.4	6.3	5.8	5.7	4.9	Q
Finishing Phase						
ADG (kg)	1.31	1.25	1.26	1.17	1.13	L
DM intake (kg/day)	10.0[ab]	9.9[ab]	10.3[a]	9.7[ab]	9.3[b]	*
FCR (kg DM/ kg ADG)	8.1	8.2	8.4	8.4	8.5	NS
Slaughter weight (kg)	559	564	571	563	552	NS
Carcass weight (kg)	304[a]	308[ab]	319[b]	317[ab]	312[ab]	*
Kill-out proportion (g/kg)	545	547	559	562	563	L
Conformation score (1-15)	8.0[a]	8.1[a]	8.5[ab]	9.1[b]	8.4[ab]	*
Fat score (1-15)	7.5	8.2	7.4	7.1	6.4	L

[1] **L**=linear response; Q=quadratic response (P<0.05) **Source:** Magee *et al.* 2015a – Teagasc Grange

Table 4: Effect of inclusion level of wheat dried distillers grains in a barley-soya based concentrate on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of steers

	Wheat distillers inclusion level (g/kg)					Sig.[1]
	0	200	400	600	800	
Growing Phase						
ADG (kg)	0.87	1.00	1.08	1.11	1.13	L
DM intake (kg/day)	6.9[a]	6.9[a]	6.8[ab]	6.8[ab]	6.5[b]	*
FCR (kg DM/ kg ADG)	8.4	7.2	6.3	6.1	6.0	L
Finishing Phase						
ADG (kg)	1.31	1.37	1.07	1.04	1.09	L
DM intake (kg/day)	10.0	10.2	10.2	10.0	10.0	NS
FCR (kg DM/ kg ADG)	8.2	7.6	9.8	10.2	9.6	L
Slaughter weight (kg)	559	560	559	543	546	NS
Carcass weight (kg)	304	313	310	301	302	NS
Kill-out proportion (g/kg)	545	559	554	553	554	NS
Conformation score (1-15)	8.0[a]	9.0[b]	8.2[ab]	7.8[a]	8.4[ab]	*
Fat score (1-15)	7.5	7.4	7.0	6.5	6.5	L

[1] **L** = linear response; Q=quadratic response (P<0.05) **Source:** Magee *et al.* 2015b – Teagasc Grange

Soya hulls

Intake and performance of beef cattle offered a barley-based ration with increasing levels of inclusion of soya hulls as a supplement to grass silage ('growing phase' experiment) and, to appetite ('finishing phase' experiment) were evaluated (Table 5). The concentrates assessed were: a barley-soya 'control' ration (same formulation as above), and barley-soya based rations where the barley was replaced with 200, 400, 600, and 800 g fresh weight/kg with soya hulls. Concentrates were prepared as coarse mixtures and formulated to have a similar concentration of true protein digestible in the small intestine on a DM basis. Steers were individually offered 3.0 kg DM of the respective concentrates as a supplement to moderate digestibility grass silage offered *ad libitum* during a 71-day growing study. At the end of this experiment steers were offered grass silage only to appetite for 21 days and then randomly re-assigned to the one of the five concentrates outlined earlier. Following a dietary adaption period, the concentrates were offered *ad libitum* plus 3 kg fresh weight grass silage daily during a 70-day finishing study.

Under the conditions of this study, results based on intake and growth suggested that the optimum soya hulls inclusion level in a barley-based concentrate was ca. 200g/kg, both when the ration was offered as a supplement to grass silage and *ad libitum*.

Table 5: Effect of inclusion level of soya hulls in a barley-based concentrate on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of steers

	Soya hulls inclusion level (g/kg)					Sig.[1]
	0	200	400	600	800	
Growing Experiment						
ADG (kg)	0.78	0.78	0.67	0.60	0.70	L
DM intake (kg/day)	7.3	7.5	7.4	7.4	7.3	NS
FCR (kg DM/ kg ADG)	9.7	10.0	11.1	13.3	10.9	L
Finishing Experiment						
ADG (kg)	1.44	1.45	1.17	1.19	1.04	L
DM intake (kg/day)	11.1	11.7	11.7	12.8	11.9	L
FCR (kg DM/ kg ADG)	7.9	8.6	10.5	11.3	11.9	L
Slaughter weight (kg)	676	675	662	650	644	L
Carcass weight (kg)	382	393	374	366	367	Q
Kill-out proportion (g/kg)	562[ab]	572[a]	562[ab]	550[b]	564[ab]	**
Conformation score (1-15)	9.0	9.3	8.7	8.6	8.9	NS
Fat score (1-15)	8.6[a]	8.4[a]	7.8[a]	8.8[a]	6.7[b]	***

[1] **L**=linear response & Q=quadratic response (P<0.05)

Source: Magee *et al.* 2015c – Teagasc Grange

Palm kernel expeller meal

Palm kernel expeller meal is a by-product of palm oil manufacture obtained by expeller (screw press) processing of dried palm kernels, from which the kernel or shell is removed. Intake and performance of beef cattle offered a barley-based ration with increasing levels of inclusion of palm kernel expeller meal as a supplement to grass silage ('growing phase' experiment) and, subsequently, to appetite ('finishing phase' experiment) were evaluated (Magee *et al*., 2016). The concentrates assessed were: a barley-soya 'control' ration (same formulation as above), and barley-soya based rations where the barley (and some, or all, of the soya-bean meal) was replaced with 100, 200, 300, and 400 g palm kernel expeller meal (Crude protein 158, and oil 72, g/kg DM) per kg fresh weight. Concentrates were prepared as coarse mixtures. Steers were individually offered 3.0 kg DM of the respective concentrates as a supplement to moderate digestibility grass silage offered *ad libitum* during a 71 day growing study then, randomly re-assigned to the one of the five concentrates which were subsequently offered *ad libitum* during a 70-day finishing study. Overall, it was concluded that, under the conditions of this study palm kernel expeller meal can be included in a barley-based concentrate at up to 400g/kg when offered as a supplement to grass silage and up to 100g/kg when the concentrate is offered *ad libitum*.

Citrus pulp

Intake and performance of finishing beef cattle offered a barley-based ration with increasing levels of inclusion of dried citrus pulp as a supplement to grass silage was evaluated (Table 6). The concentrates assessed were: a barley-soya 'control' ration (same formulation as above), and barley-soya based rations where the barley was replaced with, 400 and 800 g citrus pulp per kg fresh weight. Concentrates were prepared as coarse mixtures and formulated to have similar concentrations of true protein digestible in the small intestine per kg DM. Steers were individually offered 4.0 kg DM of the respective concentrates as a supplement to high-digestibility grass silage offered *ad libitum* during a 134 day finishing study. Under the conditions of this study, it was concluded that citrus pulp can replace barley at up to 400g/kg in a concentrate when offered as a supplement to grass silage without negatively affecting animal performance.

Table 6: Effects of inclusion of dried citrus pulp in a barley-based concentrate supplement on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of finishing steers offered grass silage

	Citrus pulp inclusion level (g/kg)			Sig.
	0	400	800	
Initial weight (kg)	447	441	450	-
End weight (kg)	578	576	559	NS
ADG (kg)	1.03[a]	1.05[a]	0.88[b]	**
Silage DM intake (kg/day)	5.3	4.9	4.9	NS
Total DM intake (kg/day)	9.3	8.9	8.9	NS
FCR (kg DM/ kg ADG)	9.2[a]	8.6[a]	10.4[b]	**
Carcass weight (kg)	330	329	322	NS
Kill-out proportion (g/kg)	561	562	568	NS
Carcass conformation score (1-15)	8.8	9.2	8.8	NS
Carcass fat score (1-15)	7.6	7.9	7.2	NS

Source: Kelly *et al*. 2017 – Teagasc Grange

Corn gluten feed

Dried corn gluten feed, a by-product of the wet corn milling industry, is the portion of the corn kernel that remains after extraction of starch, gluten, and germ and, is composed primarily of bran, the fibrous fraction of the kernel, and steep liquor.

Table 7: Effect of dried corn gluten feed inclusion level in a barley-based concentrate on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of finishing steers offered grass silage

	Corn gluten feed inclusion level (g/kg)				Sig.
	0	250	500	750	
Initial weight (kg)	451	446	443	439	NS
End weight (kg)	580	573	575	563	NS
ADG (kg)	1.04	1.02	1.06	0.99	NS
Silage DM intake (kg/day)	5.3	5.2	5.3	4.9	NS
Total DM intake (kg/day)	9.3	9.2	9.3	8.9	NS
FCR (kg DM/ kg ADG)	9.0	9.1	9.0	9.2	NS
Carcass weight (kg)	330	330	331	328	NS
Kill-out proportion (g/kg)	561	572	568	573	NS
Carcass conformation score (1-15)	8.9	9.3	9.3	9.4	NS
Carcass fat score (1-15)	7.7	6.9	7.5	7.1	NS

Source: Kelly *et al*. 2018 – Teagasc Grange

Intake and performance of finishing beef cattle offered a barley-based ration with increasing levels of inclusion of dried corn gluten feed as a supplement to grass silage was evaluated (Table 7). The concentrates assessed were: a barley-soya 'control' ration (same formulation as above), and barley-soya based rations where the barley (and all the soya-bean meal) was replaced with, 250, 500, and 750 g dried corn gluten feed per kg fresh weight. Concentrates were prepared as coarse mixtures. Steers were individually offered 4.0 kg DM of the respective concentrates as a supplement to high-digestibility grass silage offered *ad libitum* during a 134 day finishing study. Intake, growth and carcass traits did not differ between the concentrates. Under the conditions of this experiment, dry corn gluten feed had a feeding value comparable to that of rolled barley/soyabean meal when included at up to 750 g/kg in a concentrate supplement to high-digestibility grass silage.

Maize grain

Processed maize grain is usually included in cattle rations to increase performance and, mainly due to anecdotal evidence, to increase the rate of fat deposition and, thus, achieve earlier 'finish'. The effect of replacing half the barley in a barley-soya concentrate ration (same formulation as above) with maize meal (plus sufficient soyabean meal to ensure adequate dietary protein) on the performance of suckler bulls offered concentrates and grass silage *ad libitum* over 86 days was evaluated (Table 8). Compared to the barley-soya concentrate ration, carcass weight was higher and feed efficiency was better for the maize meal-based ration, whereas carcass weight and feed efficiency was similar for the flaked-toasted maize ration. Maize inclusion in the diet did not enhance carcass fat deposition.

Table 8: Effect of maize meal or flaked-toasted maize inclusion in a barley-based concentrate on dry matter (DM) intake, daily live weight gain (ADG), feed conversion ratio (FCR) and carcass traits of finishing suckler bulls

	Barley/soya	Maize meal 50%	Flaked-toasted maize 50%	Sig.
DM intake (kg/day)				
Concentrate	10.3[ab]	9.4[a]	10.4[b]	*
Silage	1.5[a]	1.5[a]	1.3[b]	*
Total	11.8	10.9	11.7	0.09
ADG (kg)	1.81	2.04	1.87	0.08
FCR (kg DM/kg ADG)	6.4[a]	5.3[b]	6.1[ab]	*
Slaughter weight (kg)	708	732	713	0.06
Carcass weight (kg)	406[a]	420[b]	409[ab]	*
Kill-out proportion (g/kg)	574	574	574	NS
Carcass conformation score (1-15)	9.9	10.4	9.8	NS
Carcass fat score (1-15)	8.3	7.7	7.4	0.06
Ribs joint weight (kg)	10.75[a]	11.46[b]	11.21[ab]	**
Lean proportion (g/kg)	658	669	664	NS
Fat proportion (g/kg)	136	124	130	NS
Bone proportion (g/kg)	205	205	205	NS

Source: Lenehan *et al.* 2015b – Teagasc Grange

Conclusion

In general, the feeding value of by-product feed ingredients is a function of their inclusion level in the concentrate and whether the concentrate is offered as a supplement to grass silage or to appetite with restricted grass silage. These findings imply that 'associative effects' between grass silage and concentrate feed ingredients have consequences for feed utilisation and thus, the nutritive value assigned to by-product feed ingredients. This means that the relative economic value of by-product feed ingredients is contingent on concentrate feeding practices. Collectively the results show that beef farmers, and the animal feed industry, have the opportunity to source alternative (cost-effective) feed ingredients as supplements to grass silage.

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