

# BEEF 2016

## *'Profitable Technologies'*

**Tuesday, 5th July, 2016**

**Teagasc, Grange, Dunsany, Co. Meath**



# BEEF2016

Profitable technologies

## SITEMAP

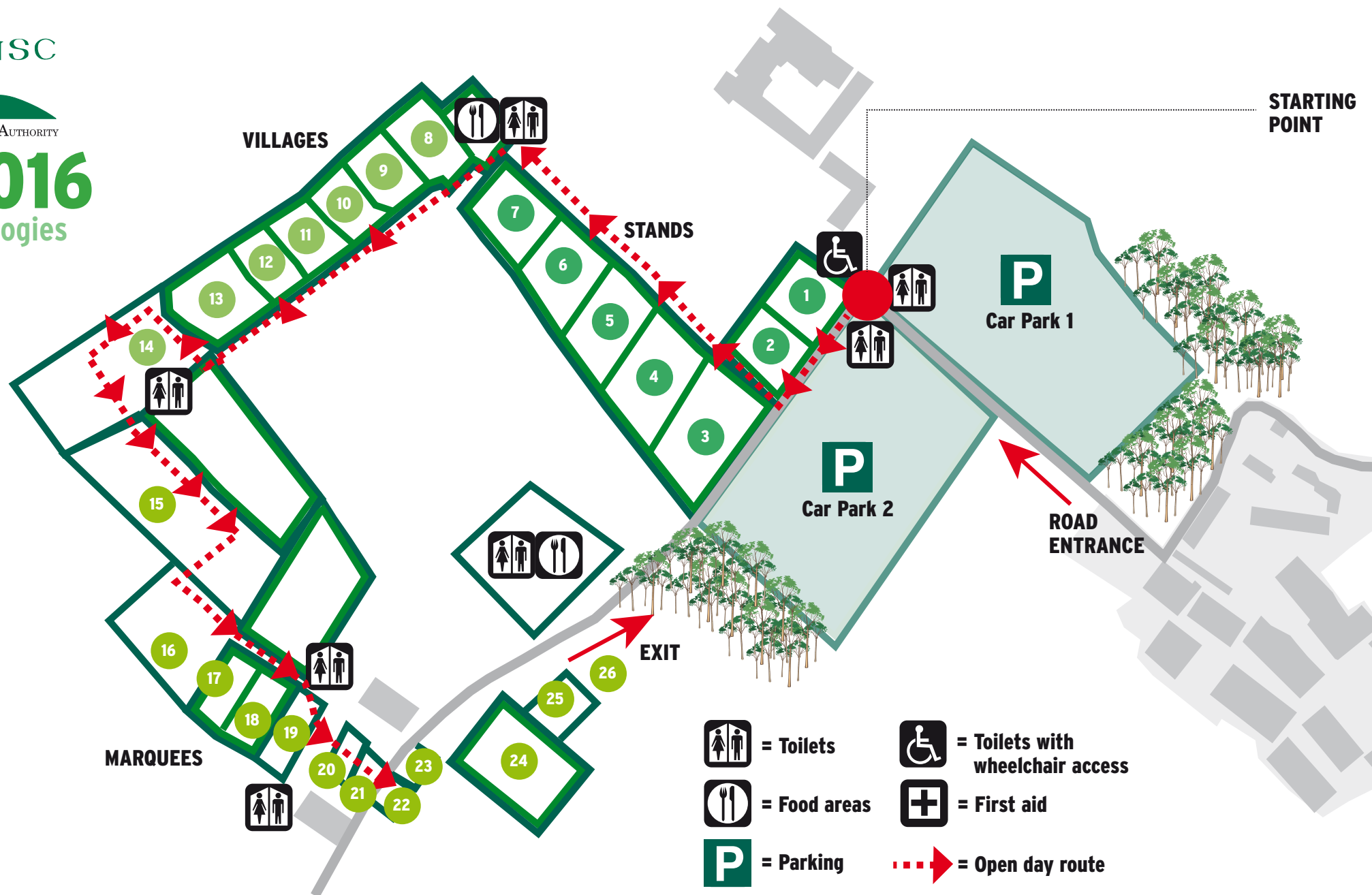
### STANDS

- 1 Welcome and introduction
- 2 Publication booklets
- 3 Suckler calf to beef
- 4 Dairy calf to beef
- 5 Exploiting genetics
- 6 Grassland management
- 7 Reproduction and health

### VILLAGES

- 8 BETTER farm beef programme
- 9 Feed to meat
- 10 Improving animal health
- 11 Beef systems
- 12 Breeding - fertility and reproduction
- 13 Sustainable farm environment
- 14 Grassland

- 15 Reseeding demonstration
- 16 Education
- 17 ICBF
- 18 Bord Bia marquee
- 19 Irish Farmers Journal
- 20 Livestock demonstration
- 21 Health and safety demonstration
- 22 Mobile health check unit
- 23 FBD
- 24 Forum
- 25 KT registration point
- 26 Public relations





# BEEF 2016

## ACKNOWLEDGEMENTS

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**5th July 2016**

*Compiled and edited by:*  
Mark McGee and Paul Crosson

Teagasc, Grange Animal & Grassland Research and Innovation Centre

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# Table of contents

<b>Foreword .....</b>	<b>9</b>
<i>Director</i>	
<b>Beef 2016 – Welcome to Grange .....</b>	<b>10</b>
<i>Edward O’Riordan and Con Feighery</i>	

## BEEF PRODUCTION: SYSTEMS AND KEY PRINCIPLES

<b>Suckler beef systems – assessing steps to improve profitability... ..</b>	<b>14</b>
<i>Paul Crosson, Adam Woods and James Keane</i>	
<b>Blueprints for dairy calf-to-beef systems .....</b>	<b>20</b>
<i>Robert Prendiville and Gordon Peppard</i>	
<b>Exploiting genetics for suckler beef systems.....</b>	<b>26</b>
<i>Nóirín McHugh, Vivian Silke and Chris Daly</i>	
<b>Increasing grass utilisation on beef farms .....</b>	<b>32</b>
<i>Michael O’Donovan, Pearse Kelly and Micheál O’Leary</i>	
<b>Fertility and health management of suckler cow herds .....</b>	<b>38</b>
<i>David Kenny, Michael Diskin, Christy Watson and Riona Sayers</i>	

## Technology Villages

### TEAGASC / IRISH FARMERS JOURNAL BETTER FARM BEEF PROGRAMME

<b>Lessons learned from the Teagasc/Irish Farmers Journal BETTER Farm Beef Programme .....</b>	<b>46</b>
<i>Alan Dillon, Peter Lawrence, Catherine Egan and Rachel Taylor</i>	

### FEED TO MEAT

<b>Grass silage for beef production .....</b>	<b>52</b>
<i>Joe Patton</i>	
<b>Concentrate feeding for growing and finishing cattle .....</b>	<b>56</b>
<i>Mark McGee, Edward O’Riordan and Aidan Moloney</i>	

<b>Feed efficient beef cattle .....</b>	<b>60</b>
<i>Claire Fitzsimons, Sean Coyle, David Kenny, Sinead Waters and Mark McGee</i>	
<b>Male suckler cattle production .....</b>	<b>64</b>
<i>Edward O'Riordan, Mark McGee, Aidan Moloney, Paul Crosson, Declan Marren, Kevin McMenamin, Ciaran Lenehan and Alan Kelly</i>	
<b>Can the producer influence beef quality for the consumer? .....</b>	<b>68</b>
<i>Aidan Moloney, Pdraig O'Kiely, Mark McGee, Edward O'Riordan, Lara Moran and Paul Allen</i>	

## IMPROVING ANIMAL HEALTH

<b>Passive immunity and health of suckler beef and dairy calves .....</b>	<b>74</b>
<i>Cynthia Todd, Mark McGee, Paul Crosson and Bernadette Earley</i>	
<b>Parasite control at grass .....</b>	<b>78</b>
<i>Rebecca Carroll, Andy Forbes and David Graham</i>	
<b>Dosing cattle and delaying the development of wormer resistance .....</b>	<b>82</b>
<i>James O'Shaughnessy, Maresa Sheehan, William Byrne and Mícheál Casey</i>	
<b>Herd health planning .....</b>	<b>86</b>
<i>Frank O'Sullivan</i>	

## BEEF SYSTEMS – TARGETS AND PLANNING

<b>Teagasc suckler beef research and demonstration herds .....</b>	<b>92</b>
<i>Adam Woods, Michael Fagan, Liam McWeeney and Matthew Murphy</i>	
<b>Dairy calf-to-beef production: a real alternative.....</b>	<b>96</b>
<i>Brian Murphy, Brendan Swan and Robert Prendiville</i>	
<b>Organic beef production .....</b>	<b>100</b>
<i>Dan Clavin and Elaine Leavy</i>	
<b>Improving our understanding of cattle enterprises in Ireland ....</b>	<b>104</b>
<i>David Meredith, Kevin Hanrahan, Francis Ryan and Geraldine Murphy</i>	
<b>Collaborative farming options on beef farms.....</b>	<b>108</b>
<i>Thomas Curran</i>	
<b>Profitable cattle farming – financial measurement and planning are key .....</b>	<b>112</b>
<i>Kevin Connolly</i>	

## BREEDING – FERTILITY AND REPRODUCTION

<b>Feeding the suckler cow for optimal reproductive efficiency.....</b>	<b>118</b>
<i>Alan Kelly, Mark McGee and David Kenny</i>	
<b>Maximizing the use of artificial insemination in suckler herds....</b>	<b>122</b>
<i>Federico Randi, Mervyn Parr, Micheal Diskin, Francis Lively, Patrick Lonergan and David Kenny</i>	
<b>Current research on the role of infectious diseases and trace elements in the fertility of beef cow herds .....</b>	<b>126</b>
<i>Mervyn Parr, Damien Barrett, Michael Diskin, Noirin McHugh, Patrick Lonergan, Francis Lively, Richard Lynch and David Kenny</i>	
<b>The Maternal Herd .....</b>	<b>130</b>
<i>Simone McCabe, Noirin McHugh, Eddie Mulligan and Robert Prendiville</i>	
<b>Genomics and fertility in beef cattle .....</b>	<b>134</b>
<i>Sinéad M. Waters, Carla Surlis and David A. Kenny</i>	
<b>Bull fertility: Important issues and current research .....</b>	<b>138</b>
<i>David Kenny, Colin Byrne, Anne-Marie English and Sean Fair</i>	

## SUSTAINABLE FARM ENVIRONMENT

<b>Sustainable land drainage design .....</b>	<b>144</b>
<i>Pat Tuohy, Owen Fenton and James O Loughlin</i>	
<b>Lime - the key to sustainable grass production on drystock farms</b>	<b>148</b>
<i>Mark Plunkett, David Wall and Patrick Forrestal</i>	
<b>Making best use of cattle slurry .....</b>	<b>152</b>
<i>Mark Plunkett, Tim Hyde, Patrick Forrestal, William Burchill, Gary Lanigan and David Wall</i>	
<b>Water quality and sustainability .....</b>	<b>156</b>
<i>Ger Shortle, Per-Erik Mellander and Tom O'Connell</i>	
<b>Ireland's green credentials: the role of farmland habitats and GLAS .....</b>	<b>160</b>
<i>Catherine Keena, John Finn and Daire O hUallachain</i>	



## GRASSLAND

- Reseeding, fertiliser and white clover for beef systems..... 166**  
*Philip Creighton, Michael O'Donovan, Brian McCarthy, Michael Egan  
 and Adam Woods*
- On farm grass variety performance and developments in the  
 Pasture Profit Index (PPI) ..... 170**  
*Michael O'Donovan, Nicky Byrne, Michael O'Leary and Noirin McHugh*

## SUPPPORTING BEEF SYSTEMS

- Agricultural education and training with Teagasc..... 176**  
*Carmel Finlay and Pdraig Gray*
- Best practice for health and safety on beef farms ..... 180**  
*John G. McNamara and Francis Collier*







# **Health, Safety and Bio-Security**

*To minimise disease risks and accidents, visitors  
entering and leaving Grange are asked to:*

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**Use Footbaths**

**Not Handle Cattle**

**Not Enter Pens or Paddocks containing Cattle**

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***Thank You***





# Beef 2016

## *Foreword*



It's a pleasure to welcome you to Beef 2016 which is Teagasc's biennial national Open Day event dedicated to the beef sector. Today's event, at the Teagasc Animal & Grassland Research and Innovation Centre in Grange, brings together our researchers, advisors and specialists as well as the main industry stakeholders involved in the beef sector to address issues and challenges facing beef farmers and the industry in the years ahead. The emphasis in Beef 2016 is on identifying those profitable technologies that will help underpin the future sustainability of the beef sector. The cattle and beef sector is of huge national economic importance, not just to the agricultural sector, but to the entire economy. It accounts for 30% of gross agricultural output and is currently valued in excess of €2.1 billion per annum. Annual beef output exceeds 500,000 tonnes, with 90% exported, which places Ireland as one of the world's major net exporters of beef. The beef sector is an important contributor to economic activity throughout Ireland. With over 90,000 farms having a cattle enterprise and approximately 7 million cattle in the country, cattle farming dominates the Irish landscape. The progeny from the 1.1 million suckler cows and most males and some females, from 1.2 million dairy cows, provide the raw material for the processing industry.

The sector faces a number of significant challenges, not least of which is the level of low profitability on to many farms. However, while some factors are outside the farmer's control, many remain within the farmer's influence and it is these challenges and opportunities that are addressed at Beef 2016. Today affords an opportunity to see and hear about the latest technologies and advances in animal breeding and grassland research and also examine the economics and profitability of the different production systems. There is also an opportunity to get the latest updates on the Maternal Index and the Newford and Derrypatrick herds. Lessons learned and technologies adopted by the farmer participants in the Teagasc / Irish Farmers Journal BETTER Farm Beef Programme will also be highlighted. The Forum at the end of today's Open Day will hear from some of the country's leading young beef farmers about the direction they are taking on their own farms. As Director, I would like to thank all of my Teagasc colleagues who have worked hard to ensure that this Beef Open Day is a success. I would also like to thank all the other organisations who partnered with us to participate in this event. I would like to acknowledge the support of FBD Trust for their sponsorship of Beef 2016. I hope you have an enjoyable and educational day and that this comprehensive booklet will provide you with the technical knowledge that you can profitably apply on your own farms

***Professor Gerry Boyle***  
*Teagasc Director*

# Beef 2016

## Welcome to Grange

*Edward O'Riordan<sup>1</sup> and Con Feighery<sup>2</sup>*

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<sup>2</sup>*Teagasc Area Manager, Westmeath, Offaly, Cavan and Monaghan*

### Introduction

On behalf of the staff at the Teagasc, Animal & Grassland Research and Innovation Centre, Grange, and other staff involved with today's event, it is a pleasure to welcome you to Beef 2016. The emphasis today is on the profitable technologies that help farmers achieve more economically and environmentally viable production systems. With its integrated programmes of research, advisory, training and education, and with the many industry stakeholders, Teagasc is well-positioned to assist farmers with technological developments aimed at improving the economics of beef farming.

Nationally, the beef industry is of major importance having a current annual output exceeding €2 billion which accounts for ~30 % of Irish agricultural output. However, unfortunately, profitability at farm level is generally low. While many factors affect farm profitability, some of which are outside the farmers' immediate control, ultimately income is derived from the difference between costs and revenue. Beef 2016 'profitable technologies', aims to address the main on-farm factors contributing to profitable beef farming.

### Beef 2016 'profitable technologies', systems of production and key principles

The key beef principles in profitable beef production systems, which are mainly under the farmers' control, are initially outlined in the first five presentations and these topics are later elaborated upon in 'technology villages'. Beef production is based on rearing progeny from the national suckler and dairy herds. The first two presentations deal with profitable beef production systems using the suckler herd and its calves (page 14), and progeny from the dairy herd (page 20). With an expanding dairy herd we can expect a greater proportion of beef being derived from this source. As beef production, at its simplest, may be seen as profitably producing and growing animals, the genetic potential of the national cattle population is hugely important. Thus, exploiting the potential of the animal through the use of the best available animal genetics (dam and sire choice) must be seen as a key feature in beef production (page 26). Grazed pasture continues to provide a competitive advantage in lowering the cost of cattle production. Fully exploiting this pasture resource, through achieving high animal performance from high yielding pasture-based systems, is seen as a key contributor to profitability (page 32). Herd health has emerged as an important cost on farms, thus, the broader issue of disease control and its prevention can, and does, play a significant role in livestock farming. Herd health permeates all aspects of livestock production and can have a major influence on many facets of production including reproductive performance of the suckler herd. The successful management of the suckler herd to achieve good fertility and a compact calving pattern is of major importance to system profitability (page 38).



## Technology villages

The beef systems and key beef principles outlines above are addressed in more detail in technology villages, each of which has 5-6 further stands. The following outlines the content of these villages:

- The Teagasc/Irish Farmers Journal BETTER farm beef programme, which outlines the advances participants have made in the programme.
- Feeding cattle is a major production cost and while aiming to fully exploit grazed pasture, the provision of additional feed stocks is an absolute necessity. Thus, information on making grass silage, the choice of concentrates and their supplementation during the winter and at pasture are presented. Research on suckler male cattle production systems and meat quality of beef is also summarised.
- Addressing herd health at farm level and planning to control diseases and their related ill-health in animals is of importance and can be a major cost to producers.
- Farming is a business, and like all enterprises, costs and revenues must be measured. The impact of farm planning, profit monitoring and cost control, collaborative farming and organic farming is outlined, as are the latest results from both the Derrypatrick and Newford herds and the dairy calf-to-beef systems research studies.
- Beef cow and replacement heifer reproduction are of major importance in suckler beef profitability. Beef cow nutrition, calf-cow management and greater use of AI are central to increasing animal output, and these areas will be addressed.
- A sustainable environment village explains the broader issue of sustainable farming, soil fertility and fertiliser use, biodiversity and greenhouse gas emissions, and carbon footprint associated with livestock.
- The Gene Ireland programme (ICBF and the breed societies) and the current, and future, national breeding programmes will be outlined.
- As over 85% of Irish beef is exported, the marketing and sale of beef is of huge importance. Bord Bia and some of the main beef processors will be present to explain current market requirements.
- Farm safety and farmers health are important issues and this village aims to highlight the importance these issues to farm families.
- Exploiting grassland to reap its full potential is a major contributor to farm profitability. Within the grassland village a range of pasture covers will be displayed and the key principles of grassland management and farm infrastructure will be discussed. Additionally, information on fertilisation of grasslands, role of clover, land drainage, reseeding of pasture, weed control in swards and PastureBase Ireland, will be presented.

Beef 2016, finishes with a 'Farmer Forum' where a group of farmers speak about their future plans for beef farming.

As in previous years, there are heightened bio-security measures in place, so please use footbaths provided and follow the directions provided. Livestock at pasture are displayed behind 'double' fences, for bio-security and safety reasons, and visitors are requested not to enter areas containing livestock. Your help and cooperation with these requirements will be appreciated.

Again, on behalf of Teagasc and Grange staff we hope you find the day useful and enjoyable.





# **Beef Production: Systems and Key Principles**

## Suckler beef systems – assessing steps to improve profitability

*Paul Crosson, Adam Woods and James Keane*

*Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath*

### Summary

- The 3 main variables to increase profitability of suckler beef systems are:
  - ▶ Increase grass utilisation. This requires good soil fertility, perennial ryegrass dominant swards and the appropriate use of grass budgeting tools.
  - ▶ Maximise animal performance. Good fertility and reproductive performance are fundamental to a profitable system with the objective being to produce one calf per cow per year. The breeding and management policy must also aim to maximise live weight gain
  - ▶ Optimise stocking rates. Economic analysis of suckler calf to beef systems in Grange has shown that, where individual animal performance is high, stocking rate is a key driver of profitability
- Production efficiency improvements are possible for ‘average’ suckler farming systems in Ireland and can lead to substantial increases in profitability.

### Introduction

Ireland is the fifth largest net exporter of beef in the world, exporting 90% of the total 520,000 tonnes of carcass weight produced in 2014, valued at just under €2.1 billion. A further 210,000 cattle, worth €162 m, were exported live. Beef production is the most ubiquitous farm enterprise activity in Ireland with the beef sector one of the main contributors to the Irish agri-food industry, accounting for 34% of total gross output value in 2014. Of the 139,000 farms nationally, beef production activities occur on almost 80% with this output largely generated from the progeny of the suckler beef cow herd. Despite the significance of the beef sector to the national economy, family farm incomes are low, with many beef enterprises operating at a loss when EU and national farm support payments are excluded. Improving profitability on suckler beef farms nationally is a challenge for all stakeholders associated with the industry. The purpose of this chapter is to outline the key factors that influence the profitability of suckler beef systems and in this context to present analysis highlighting the importance of suckler farms operating to very high levels of management and production efficiency.

### Factors affecting profitability of suckler beef systems

The three main variables influencing the profitability of suckler beef enterprises are; 1) grass utilisation, 2) animal performance and, 3) stocking rates.

#### *Grass utilisation*

The level of grass (grazed and conserved) utilised on beef farms is firstly determined by the yield of grass grown, which in turn depends on soil fertility. The results of soil analysis from Irish grassland farms have shown that 90% of samples have sub-optimal soil fertility (see page

32). More specifically, it has been shown that 70% of drystock farms have a large requirement for lime and over half of the soils tested have very low to low Phosphorous (P, 54%) and Potassium (K, 50%) status. Thus, soil testing, to establish current levels of soil fertility, is the initial step to increasing the level of grass utilisation on beef farms.

Where soil fertility is corrected, beef farms can grow up to 15 t DM/ha of grass. This has to be utilised efficiently to maximise live weight gain; paddock-based grazing systems, facilitating rotational grazing management, is a key component of good grassland management. Good rotational grazing infrastructure, including a network of farm roadways and paddocks, gives flexibility to manage grassland and identify deficits and surpluses as they arise. Practices such as removing excess herbage as bales and restricted grazing in difficult weather conditions are more feasible where there is good grazing infrastructure.

New grass measuring and budgeting tools such as PastureBase Ireland (see page 32) also facilitates better decision-making by farmers. The confidence to make decisions, such as the removal of paddocks from the grazing rotation is critical. Such decisions become based on quality information such as the number of grazing days ahead and the 'grass wedge' on the farm. The use of an easily accessible computer programme thus, becomes a useful aid to grassland management

Reseeding also has an important role to play in maximising growth and in turn utilisation (see page 166). Perennial rye-grass swards have shown to be up to 25% more responsive to available nutrients such as nitrogen when compared to old permanent pasture. Reseeding increases the overall productivity of the farm by increasing stock carrying capacity and the proportion of the overall feed budget that is comprised of grazed grass.

## *Animal performance*

The main objective on suckler beef farms is to maximise the value of the animals sold as either beef carcass weight or live weight per suckler cow on the farm. The amount of beef produced on suckler beef farms depends on a myriad of animal performance factors such as live weight gain, mortality and fertility. Data from the Irish Cattle Breeding Federation (ICBF) shows that only 83 out of every 100 cows produce a calf every year and that calf mortality in 2015 was 6% at 28 days.

Good cow fertility and reproductive performance is key to profitability with the objective being to produce one calf per cow per year. There is huge potential to increase the fertility and performance of our national suckler cow base, which in turn will increase productivity and profitability at farm-gate. The introduction of genomic selection (see page 134) will allow farmers to identify the most productive and fertile heifers for breeding at a very young age on the farm. With this information at farm level suckler beef farmers can select bulls on either the Replacement Index (breeding replacement heifers) or the Terminal Index (finishing systems/weanling systems) depending on the production system (see page 26). Genomic selection will help to give farmers the knowledge and confidence to make informed breeding decisions.

The breeding policy on all suckler beef farms should be to maximise live weight gain through exploiting breed differences and hybrid vigour. Research has clearly shown that using a crossbred cow as opposed to a purebred cow results in an increase of 13% in terms of weaning weight of calf per cow. Herd health planning is also an important aspect of good animal performance and should focus on preventative strategies as opposed to dealing with an outbreak when it arises. Health plans are specific to each farm and should be drawn up between the farmer and their local veterinary practitioner. Particularly where an outbreak on a farm has occurred recently an important first step is to sit down with your local veterinary practitioner and discuss prevention strategies.

Utilising best husbandry practices is a key to maximising animal performance. In terms of animal health, disbudding, castration, dosing and parasite control are all important to have a healthy, stress free animal. When housed, animals must have fresh feed and water, shelter and adequate space to maximise live weight gain.

## *Stocking rates*

Economic analysis of suckler calf to beef systems in Grange has shown that, where individual animal performance is high, stocking rate is the main driver of profitability. It is essential that increases in stocking rate are supported by higher levels of grass grown on the farm. In addition to the aforementioned grazing principles (infrastructure, reseeding, grass budgeting, etc.) soil type and location also has an impact on stock carrying capacity.

Other factors which influence the optimal stocking rate for beef farms include facilities and labour availability. If animal housing and handling facilities are not in place when increasing stocking rates, then extra stress and pressure at key points in the production cycle e.g. calving, will impact on performance metrics such as live weight gain and reproduction. It is important to note that there is a close relationship between facilities and labour; improving farm facilities and handling units as well as the farm business system will all improve the efficiency of labour use on farms. Farmers should avail of schemes such as the Targeted Agricultural Modernisation Scheme (TAMS) to help improve facilities on their farms.

## **System comparisons**

The implications of production efficiency and level of output were evaluated by comparing five alternative production systems which differed in respect of: animal productive and reproductive performance, grass utilisation, calving pattern and date and finishing systems (Table 1). The analysis excluded land and labour charges and therefore reflects a family farm situation on owned land. To maintain the focus of the analysis on factors affecting the beef enterprise, all direct support payments, such as the Basic Payment Scheme, were excluded from the analysis. The first production system (*Option 1*) represented national average levels of performance and beef output. Thus, this system consisted of finishing steers and heifers at 30 and 26 months of age, respectively. Calving was in February (20%), March (25%), April (30%) and May (25%) and thus, mean calving date was 2 April. Weaning weight was 250 kg with 0.83 calves per cow produced annually. Age at first calving was 36 months. The relatively low level of efficiency was reflected in high production costs and low levels of profitability.

Broadly speaking, farmers have two options to increase profitability; increase output and/or improve efficiency (thereby reducing production costs per kg of beef carcass). It is generally accepted that both are necessary to maximise profitability; however, the next two scenarios set out to evaluate the implications of both options independently.

It is imperative that increases in output are coupled, and indeed preceded by, high levels of production efficiency (i.e. reproductive and productive performance). To highlight the risk of increasing output without concomitant increases in efficiency, the second scenario (*Option 2*) evaluated a system whereby, efficiency levels were similar to Option 1 but stocking rate was increased to 2 LU/ha. The increase in stocking rate was facilitated by higher levels of both fertiliser nitrogen application and meal feeding. Weaning and carcass weights were greater than Option 1 as a result of greater levels of meal feeding and accordingly, beef output was increased by 74%. However, production costs were similar to Option 1 and net margin also remained negative, albeit with a modest improvement relative to Option 1. A further potential issue is the higher carcass weight for steers in this scenario (435 kg) which is



greater than the current Meat Industry Ireland specifications and thus, may limit sale options and price. Overall it is clear that increasing output in this manner is not an economically viable proposition, particularly when one considers that cow numbers were 60% greater than Option 1.

**Table 1.** A comparison of suckler beef production systems differing in production efficiency and output.

	Option 1	Option 2	Option 3	Option 4	Option 5
<b>Level of output</b>	<b>National average</b>	<b>High</b>	<b>National average</b>	<b>High</b>	<b>High</b>
<b>Level of efficiency</b>	<b>National average</b>	<b>National average</b>	<b>High</b>	<b>High</b>	<b>High (bulls)</b>
Suckler cows on 40 ha	23	37	31	<b>53</b>	<b>61</b>
Stocking rate (LU/ha)	1.27	<b>2.00</b>	1.32	<b>2.22</b>	2.24
Male finishing system	30 mo steer	30 mo steer	<b>24 mo steer</b>	24 mo steer	<b>16 mo bull</b>
Heifer finishing system	26 mo	26 mo	<b>20 mo</b>	20 mo	20 mo
Fertiliser nitrogen use (kg/ha)	55	<b>175</b>	55	<b>105</b>	<b>87</b>
Meal consumed (t/LU)	0.25	<b>0.54</b>	0.38	0.42	<b>0.74</b>
Grass consumed (t DM/ha)	4.6	7.2	5.2	8.7	8.2
Mean calving date	02-Apr	02-Apr	<b>06-Mar</b>	06-Mar	06-Mar
Average weaning weight (kg) <sup>1</sup>	250	<b>257</b>	<b>293</b>	293	293
Average carcass weight (kg) <sup>1</sup>	374	404	370	370	355
Calving rate (calves/cow/year)	0.83	0.83	<b>0.95</b>	0.95	0.95
Age at first calving	36 mo	36mo	<b>24 mo</b>	24 mo	24 mo
Beef output (kg live)	11,873	20,670	18,578	31,265	34,508
Variable and fixed costs (€/kg live) <sup>2</sup>	2.51	2.37	1.81	1.59	1.64
Gross margin (€/farm) <sup>2</sup>	12,898	15,961	25,884	<b>42,992</b>	<b>44,331</b>
Net margin (€/farm) <sup>2</sup>	-3,512	-3,026	8,439	<b>21,026</b>	<b>22,595</b>
Conc price sensitivity <sup>3</sup>	16	54	25	46	83
Beef price sensitivity <sup>4</sup>	82	139	129	217	244

<sup>1</sup>Average of male (steers or bulls) and heifer progeny. <sup>2</sup>Excludes land and labour charges. These costs are provided in the text. <sup>3</sup>Impact on net margin (€/ha) per €50/t change in concentrate price. <sup>4</sup>Impact on net margin (€/ha) per 50 c/kg change in beef carcass price.

*Option 3* involves a production system where the emphasis is placed on achieving high levels of efficiency rather than output. Hence, fertiliser N application (the key driver of beef output in pastoral systems) is the same as Option 1. Reflecting higher levels of animal live weight performance, steers and heifers are finished six months earlier than Option 1 at similar carcass weights. The higher live weight performance is also indicated by the greater weaning weights in this scenario. Reproductive performance is also much improved with 0.95

calves per cow produced annually and first calving occurring at 24 months of age. Due to the higher rate of grass utilisation (80% vs 70% in Option 1), the earlier slaughter age and the earlier age at first calving, cow numbers, and thus, beef output, is much greater than Option 1. Overall, production costs are almost 30% lower than Option 1 and gross and net margin are also much higher.

To assess the impact of increasing both production efficiency and output on suckler beef farms a fourth scenario (*Option 4*; high efficiency and high output) was considered. In this scenario the production system was similar to Option 2 and stocking rate was increased to the maximum permissible by the Nitrates Directive (170 kg organic N per hectare). In this scenario, production costs are substantially reduced being 37% lower than Option 1, and accordingly, profitability is much higher. This thus, highlights the requirement to couple both relatively high stocking rates, which drives beef output, and good production (grazing and animal) efficiency to maximise profitability of suckler beef systems. Research from Teagasc, Grange has shown that increases in stocking rates above those included in the present analysis can further increase profitability (see page 92 for descriptions of the Teagasc research demonstration suckler herds). In such circumstances, production costs per kg beef are likely to increase but profitability increases arising from higher levels of beef output.

The opportunity to take advantage of the inherent efficiency of bulls (see page 64) was explored in the final scenario (*Option 5*). In this case all other aspects of production were similar to Option 4, however, males were finished as bulls at 16 months of age. Earlier slaughter and lower forage demand of these animals relative to steers in Option 4 led to an increase in the number of cows in this scenario. Carcass weight was lower but total live weight output was greater than Option 4. Although production costs were slightly greater than Option 4, profitability was greater and indeed was the greatest of all scenarios.

## Factors affecting profitability

The importance of reproductive and productive efficiency on the economic performance of suckler beef systems is clear from the data presented in Table 1. To further highlight this, the key individual factors which affect profitability were evaluated independently for Option 4. The analysis shows that grass consumption, calving rate, age at first calving and live weight gain all have very important effects on profitability (Table 2). It is important to note that these effects are in the context of an already efficient production system and thus, the effect of unit changes in each of these efficiency factors will be different for the other options presented in Table 1.

The objective of the above analysis was to highlight the importance of both production efficiency and output for profitable suckler beef systems. For many farmers, the level of output evaluated in Options 4 and 5 in Table 1 will not be possible due to factors such as facility constraints, labour availability and soil-type limitations. However, there will be many farmers who can (and do) operate at a higher stocking rate (availing of a derogation from the Nitrates Directive) and indeed, the Teagasc research demonstration farms typically operate at stocking rates in excess of 200 kg organic N per hectare. Regardless, the intention is not to suggest that this level of output is required; rather the principle is that farmers should operate at the highest level of output permissible according to their own set of circumstances. In any event, a prerequisite is that production efficiency should be as high as possible and certainly much higher than that which prevails for 'average' suckler farming systems in Ireland. This can be viewed in terms of relative production costs; Options 4 and 5 produce beef at approximately 64% of the cost of Option 1. In terms of national comparisons, the production

costs for Options 4 and 5 can be compared to the average of €1.84 per kg live weight for the farms participating in the Teagasc/Farmers Journal BETTER Farm beef programme (Page 46).

**Table 2.** Factors affecting the profitability of suckler calf to beef production systems. Baseline system against which data is calculated is based on Option 4 presented in Table 1.

	Effect on net margin (€/ha)
Grass (grazed and conserved) consumed (+/- 1 t DM/ha)	105
Calving rate (+/- 5%)	54
Age at first calving (24 vs. 36 months)	112
Lifetime daily live weight gain (+/- 0.1 kg)	78

Undoubtedly the question of land and labour charges arises when one considers the economics of these alternative systems. If one assumes a land charge of €400/ha (€160/acre) then the additional production cost per kg live weight for each system is €1.35, €0.86, €0.77, €0.51 and €0.46 for Options 1, 2, 3, 4 and 5, respectively; i.e. where land charge is a consideration (rented/leased land) then the importance of maximising output is amplified. In the case of labour charges, if one assumes that one labour unit can manage a 100-cow suckler unit and that each labour unit earns the average industrial wage (€36,000) then the addition cost to the above scenarios per kg live weight is €0.70, €0.61, €0.64, €0.61 and €0.64 for Options 1, 2, 3, 4 and 5, respectively. In this case, the effect of increasing output is not as pronounced as it was for land charges since output and labour charges are coupled to a much greater degree.

## Environmental sustainability

The environmental sustainability of production systems, particularly greenhouse gas emissions (more commonly known as the carbon footprint) is of increasing interest to consumers. The carbon footprint of suckler beef is influenced by the reproductive efficiency of the suckler cow herd (e.g. age at first calving and calving rate) and the daily live weight gain of progeny to weaning or slaughter. The pasture-based nature of Irish suckler beef systems also has an important role in respect of the management of the enormous reserves of carbon stored in permanent pasture soils and the capacity to further enhance these carbon reserves (i.e. sequestration). Research at Teagasc, Grange has shown that the carbon footprint of suckler systems operating at 'national average' levels of efficiency is much higher than that found for research farm systems. Typically, the scale of difference is in the order of 20%. Together with the aforementioned economic impact, this highlights the dual benefits of improving the efficiency of suckler beef production.

# Blueprints for dairy calf-to-beef systems

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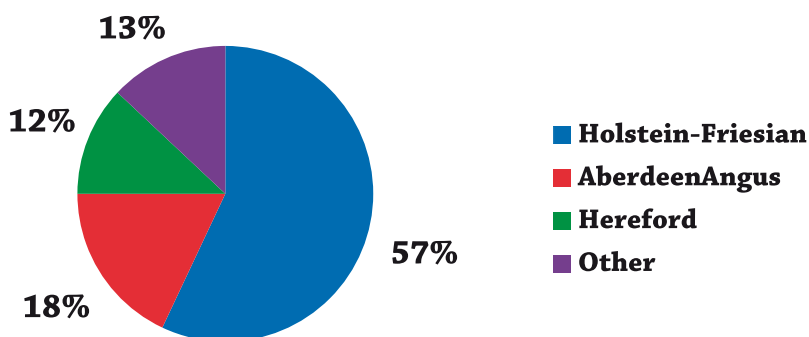
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## Summary

- Growth in the national dairy cow population will result in a proportional increase in the number of dairy calves available for beef production.
- Pasture-based early-maturing breed dairy crossbred beef production systems can produce carcasses that have adequate weight and fat cover at slaughter.
- Dairy beef production systems are sensitive to calf purchase price, concentrate price and selling price.
- Systems that utilise high quantities of pasture and are focused on high output per hectare are fundamental to the profitability of the production systems.

## Introduction

Growth in the national dairy cow population will result in a proportional increase in the number of dairy calves available for beef production. Currently 57% of calves born are bred from dairy breed sires (Holstein-Friesian), 30% from early-maturing breed sires (Angus and Hereford) and the remainder from continental breed sires and other breeds (Figure 1). The profile of calves born to dairy breed sires has increased in recent years due to dairy herd expansion. However, as dairy cow numbers begin to plateau together with improvements in dairy cow reproductive efficiency, an increase in the proportion of dairy calves born from beef breeds is expected.



**Figure 1.** Sire breed profile of calves generated from the dairy herd (Animal identification and movement, 2016).

From a beef farmer's perspective a decision needs to be made on the type of calf that is purchased; Holstein-Friesian, Angus, Hereford or continental crossbred dairy bull or heifer calves? While the breed of calf does generate a lot of discussion, consideration should also be given to the production system that the calves are going to be managed within. A range

of dairy calf-to-beef production systems are available that have significant implications on investment rate, stocking rate, housing facilities, labour, concentrate input, grass and silage requirements and, most importantly, profitability. The projected sale date should be established before calves are purchased. The actual sale date is ultimately dictated by animal performance and hence, live weight performance has implications for the carrying capacity of the farm.

In recent years, a range of production systems have been evaluated at Teagasc Grange and Johnstown Castle for Holstein-Friesian calves, and Angus and Hereford dairy crossbred calves. For the purpose of this paper the blueprints and profitability of these systems are presented.

## Calf performance during their first grazing season

Optimising calf performance during their first season at pasture is essential to ensure that the targets set out in the blueprints below are achieved. The management of Holstein-Friesian calves and early-maturing breed dairy crossbred heifer and bull calves in this period are identical. Following the calf rearing stage, calves are supplemented with concentrates until mid-May (1 kg daily for 2 weeks), remain on a pasture-only diet until early September and are again supplemented with 1 kg of concentrates daily for 6 weeks until housing. Aside from male Holstein-Friesian calves allotted to the 15-month bull production system, the target average daily gain (ADG) of a calf during their first season at grass is 0.80 kg with a live weight target at housing of 230 kg. Male dairy calves assigned to the 15-month bull production system require an ADG of 0.90 kg during this period to ensure that the target carcass weight is achieved. For the other systems outlined below, animals are carried through their first winter on a diet comprised of grass silage *ad libitum* supplemented with 1.5-2.0 kg of concentrates daily. Animal ADG during the first winter is 0.7 kg. It is essential that attention to detail with regard to calf rearing, animal health and pasture management is observed to ensure that optimum animal performance is achieved.

## Blueprints for male dairy calf-to-beef production systems

Previously, the blueprint system for Holstein-Friesian cattle was for finishing at approximately two years of age at the end of the second winter in a steer production system. In this system steers were finished on a diet comprised of grass silage *ad libitum* and 5-6 kg of concentrates daily. The target carcass weight was 320 kg. More recently alternative production systems and finishing strategies have been being explored by producers. With the shift from steer to bull beef production by some producers, particularly for Holstein-Friesian animals, it is essential that the market requirements are clearly understood from the outset. Age at slaughter, carcass weight, carcass conformation and fat scores are critical issues for beef production.

### ***The blueprints for male Holstein-Friesian calves are:***

- ***15-month bull system:*** Spring-born calves are housed in late October/early November, remain indoors, and are finished on a diet comprised of concentrates offered *ad libitum* with grass silage or straw as a source of roughage. Bulls are slaughtered in May/June. During the finishing period, concentrate input is approximately 1.8 t dry matter (DM) and ADG is 1.4 kg. The target carcass weight in this system is 270 kg with carcass conformation scores of O= and fat scores 2+. Meeting these targets at less than 16 months of age is necessary to satisfy UK market specifications. In research farm systems experiments carried out at Teagasc, Johnstown Castle, the target carcass weight for this system was difficult to



achieve; additionally the system is highly vulnerable to increases in concentrate costs. It is critical that calves in this production system reach a housing live weight of 250 kg in November, at the end of the first grazing season, in order to successfully meet the market specifications.

- **19-month bull system:** Bulls are turned out to pasture in early March for the first part (100 days) of the second grazing season, housed in June and finished on concentrates offered *ad libitum* over a 100-day finishing period. Concentrate input is 1.2 t DM during the finishing phase. Average daily gains during the second season at pasture and finishing phase are 1.2 kg and 2.0 kg, respectively. Target carcass weight for this system is 320 kg. Given that these animals are greater than 16 months of age at slaughter, the market outlet for these carcasses is more limited. Therefore, very close communication with meat processors is essential for the operation of this production system.
- **21-month steer system:** For spring-born calves, winter finishing can be avoided by finishing steers (at lighter carcass weights) off pasture at the end of the second grazing season, after receiving concentrate supplementation for 60 days pre-slaughter. Concentrate input during the finishing phase for this system is 350 kg DM. Average daily gain during the second season at pasture is 1 kg. Calves need to have an early birth date (January/February) and must have good lifetime performance for this system. Target carcass weight is 280 kg. For Holstein-Friesian steers carcass conformation scores are predominately P+ and O-, and fat scores 2-.
- **28-month steer system:** Animals are at pasture for the second grazing season and are then housed and offered high quality grass silage *ad-libitum* only for the second winter. During this indoor period ADG is typically 0.5 kg. Steers are then turned out to pasture in late February/early March and slaughtered in June. Average daily gain during the third season at pasture is 1.2 kg. In this system steers achieve a carcass weight of 350 kg. Carcass conformation scores are predominately O= and fat scores 2-/2+.

## Blueprints for early-maturing calf-to-beef production systems

Early-maturing dairy beef crossbred heifers and steers have the potential to achieve a commercially acceptable level of carcass fatness at a young age. Therefore, these genotypes should be suitable for systems of production that aim to finish animals at the end of the second grazing season producing saleable carcasses at a relatively light slaughter weight. Previous research carried out in Grange evaluated the merits of early- and late-maturing dairy beef crossbred animals with the focus more recently on refining the early-maturing system blueprints as set out below.

- **Early-maturing heifer production system:** Heifers are at pasture for the first grazing season and housed in November and offered grass silage *ad-libitum* supplemented with 1.5-2.0 kg of concentrate daily depending on silage quality. After their first winter, heifers are turned out to pasture in early March and slaughtered off pasture in September, at 19 months of age, after receiving 2.5 kg concentrate DM daily for 60 days pre-slaughter. The target ADG during the second season at pasture is 0.8 kg. Target carcass weight is 235 kg with carcass conformation scores of O+ and carcass fat scores of 3-. Results from Johnstown Castle have shown that all spring-born heifers should be finished before the second winter.
- **21-month early-maturing steer system:** Steers are at pasture for the first grazing season and 'stored' during the first winter on grass silage *ad-libitum* supplemented with 1.5-2.0 kg of concentrate daily depending on silage quality. They are turned out to pasture for the second grazing season and slaughtered off pasture in November. Average daily gain during

the second season at pasture is 0.8 kg. The target carcass weight in this system is 280 kg. Average carcass conformation score was O= and carcass fat score was 3-.

- **23-month early-maturing steer system:** In this system cattle are at pasture for the second grazing season, housed and offered good quality grass silage *ad libitum* supplemented with 5-6 kg of concentrates daily for 80 days pre-slaughter. Average daily gain during the finishing phase is 1.0 kg. Target carcass weight is 300 kg with carcass conformation score of O+ and fat score 3=.
- **26-month early-maturing steer system:** Animals are at pasture for the second grazing season and are then housed and offered only grass silage *ad-libitum*, for the second winter. During this housing period ADG is typically 0.50 kg. Steers are then turned out to pasture in late February/early March and slaughtered in June. Average daily gain during the third season at pasture is 1.3 kg. The target carcass weight is 320 kg with conformation and fat scores of O+ and 3+, respectively. This system is particularly well-suited to calves born in late spring (April/May) as winter finishing is avoided and a heavier carcass weight is achieved under grazing conditions.

## Profitability of dairy calf-to-beef production systems

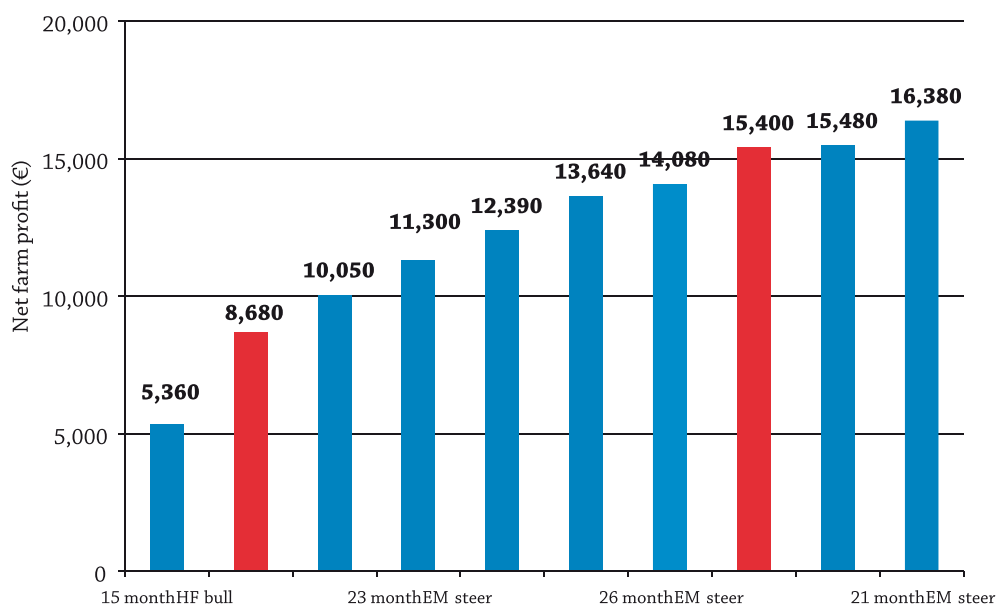
Figure 2 shows the net margin of the production systems described above based on a 20 ha (50 acre) beef enterprise farm area. Price assumptions were: male Holstein-Friesian calf purchase price, €100; early-maturing breed heifer calf, €240; early-maturing breed bull calf, €270; R3 steer beef carcass price, €4.00; and, finishing concentrate price, €255. Actual beef price payable depends on carcass grading (animal performance results generated at Johnstown Castle), seasonality (beef price being highest in May and lowest in September) and eligibility for quality assurance bonus. The breed bonuses were also included for the early-maturing breed production systems and the impact of a 30c/kg discount on the 19-month bull production system was also investigated.

Results clearly indicated that huge variation in profit exists across production systems. The 15-month Holstein-Friesian bull system has a very modest land requirement although it is important to bear in mind the organic nitrogen and slurry contribution of these cattle with regard to the stocking rate and slurry capacity limitations of the Nitrates Directive. The 15-month Holstein-Friesian bull system was the least profitable on a per head and per hectare basis. Although the traditional production systems for male dairy calves and early-maturing breed heifer and steer production systems were profitable, grass-based production systems, where animals were slaughtered in November before the second winter or in June during their third grazing season, were the most profitable. Although the 19-month Holstein-Friesian bull is one of the more profitable systems, the impact of a discount in beef price has the potential to render it one of the least profitable systems. For this system it is essential that close communication with meat processors is established and maintained.

## Sensitivity analysis

Aside from grass production and utilisation the main contributors that affect farm profitability of dairy calf-to-beef systems are concentrate costs, calf purchase price and beef carcass price. Although all of these factors affect each production system described above, the level of impact varies greatly between them. For example, dairy bulls in the 15-month production system are most sensitive to changes in concentrate price. A €10 per tonne increase in concentrate price reduces gross margin by €18 per head. On the other hand, the 19-month bull system

was most sensitive to beef price with a 10 c/kg increase/decrease in beef price increasing/reducing gross margin by €32 per head. Early-maturing breed heifer production systems and pasture-finished steers were least sensitive to concentrate and beef price. Fluctuations in beef price, concentrate price and calf price did not result in any re-ranking between the production systems within the price ranges explored. Current research at Johnstown Castle is evaluating the impact of stocking rate on dairy calf-to-beef systems.



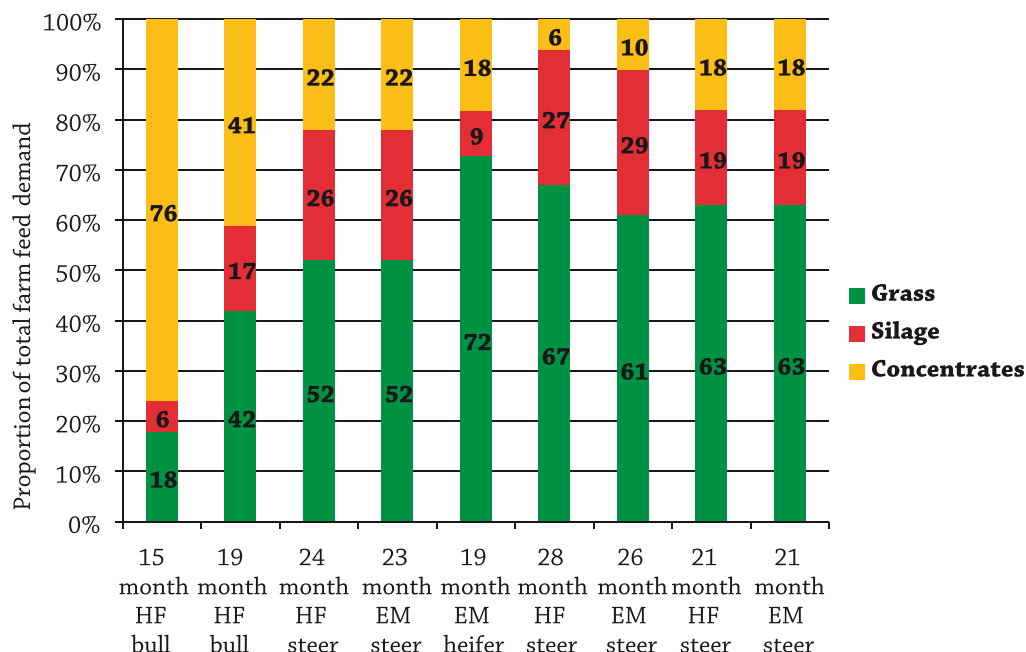
**Figure 2.** Profitability of dairy calf-to-beef production systems based on a 20 hectare beef enterprise farm area. HF= Holstein-Friesian and EM= early maturing (Angus and Hereford dairy crossbred animals) and breed bonuses are included in the early maturing production systems.

## Farm management and cash flow

From a farm management (utilisation of grazed grass and silage, availability of housing etc.) and cash flow perspective, beef producers normally operate more than one production system. It also ensures a number of sale dates throughout the year. Even with the most profitable production systems, operating a single system can be a challenge. For example, if a beef producer operates a 21-month steer production system grass demand in the spring is low because the yearlings will be approximately 320 kg at turnout with a modest grazing demand (6-7 kg DM per head) and spring-born calves will have no demand for grazed grass until after turnout in May/June. In addition, because these steers are slaughtered before the second winter the requirement for grass silage is significantly reduced. In this scenario having a proportion of steers carried through the second winter and slaughtered during their third season at pasture would complement the 21-month steer system. This would also result in a sale date for these animals that typically coincides with higher beef prices in June/July.

## Herbage production

A key element of profitable dairy calf-to-beef systems is the efficient utilisation of grazed grass. Figure 3 highlights the variation in the feed budgets for grass, grass silage and concentrates for each production system. Each system has a different requirement for grass herbage per head ranging from 2.3 t DM for the 19-month heifer systems to 4.3 t DM for the 26-month steer system (Figure 3). At a stocking rate of 200 kg organic N per hectare and assuming excellent levels of grass utilisation, the farm would need to grow between 10.1 t DM/ha and 11.6 t DM/ha for each of these systems, respectively. At 225 kg organic N per hectare this rises to 11.3 and 13.0 t DM/ha for each of these systems, respectively. Thus, the capacity of the farm to grow grass will largely dictate the stock carrying potential of the farm.



**Figure 3.** Feed budget for Holstein-Friesian and early-maturing dairy beef crossbred production systems. HF= Holstein-Friesian and EM= early maturing (Angus and Hereford dairy crossbred animals).

## Conclusion

Various production systems can be employed on dairy calf-to-beef enterprises depending on the breed type, gender and finishing system. The most successful systems are those that optimise animal performance from grazed pasture and achieve a high proportion of total life time gain from grazed grass. Profitability is vulnerable to increases in concentrate input costs and calf purchase price, as well as the selling price (including bonuses) of beef. It is also important to realise that farm profit varies depending on the production system which in turn is influenced by the breed of the calf that is purchased.

## Exploiting genetics for suckler beef systems

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### Summary

- Unlike animal management or feeding, genetics is cumulative and permanent.
- The Euro-Star Replacement and Terminal indexes are profit-based breeding indexes which can be used to select genetically elite animals.
- Farmer scored traits provide valuable information on difficult to measure traits.
- Genomic selection will increase the reliability of breeding indexes.
- Commercial suckler cows with high Replacement Index consistently outperform cows with lower star ratings.
- High Terminal Index sires produce progeny that finish faster, have superior carcass grades and yield greater profits than progeny from low index sires.

### Introduction

Genetics involves the passing on of favourable or unfavourable genes from one generation to the next and the use of genetic indexes is an important selection aid that enables farmers to select superior animals to become the parents of the next generation. The benefit of animal genetics is that, unlike management or feeding, it is cumulative and permanent – this, however, could also be a disadvantage in that poor breeding decisions, even for one year, could have devastating repercussions for many generations thereafter. A profitable Irish beef industry requires an easy calving, low-cost beef suckler cow that produces progeny with good quality carcass traits each year. The Euro-Star indexes provide farmers with the necessary information to identify the most profitable genetics for their production system. On-going research at Teagasc in conjunction with the Irish Cattle Breeding Federation (ICBF) ensures further progress is made in the generation of superior animals across a range of breeds that will increase profitability for the national beef herd.

### €uro-star Indexes - a tool to identify elite animals

The ICBF beef Euro-Star system was introduced in Ireland in 2007 and is calculated for each animal based on the results from genetic evaluations. Animals' individual performance records such as calving surveys, weights, fertility and carcass data along with all ancestry records (i.e. sire, dams and relatives) are used to predict the genetic merit of each animal. The genetic evaluations adjust for non-genetic effects such as on-farm management practices and age of dam etc. Thereafter, economic (€uro) values are applied to the genetic evaluations to rank each trait based on their economic importance at farm level. Traits weighed by their economic



importance are then grouped into Euro-Star indexes; currently two Euro-Star indexes are generated for each animal: a Replacement and a Terminal Index (described below). Table 1 highlights the relative weighting placed on the trait groups within the current Replacement and Terminal Index.

- 1. Replacement Index;** for the identification of animals suitable for breeding and selecting high profit replacement females. This index includes maternal cow traits but also terminal traits to account for progeny of the dam that are destined for slaughter. Following a comprehensive review of the Euro-Star Replacement Index in 2015 and, after consultation with industry, the decision was taken to change the definition of the Replacement Index, which has resulted in greater emphasis being placed on the maternal or female expressed traits such as maternal calving difficulty, milk yield, cow maintenance costs, calving interval and cow survival, and less weighting on progeny carcass (i.e. terminal) traits. Currently, 71% of the index is weighted towards traits of the cow and the remaining 29% is weighted towards progeny traits. A cow with a Replacement Index of €120 is expected to generate, on average, €120 more profit per lactation than the average Irish suckler cow.
- 2. Terminal Index;** for the identification of sires suitable for breeding high profit animals for slaughter. A bull with a Terminal Index of €90 is expected to sire cattle for slaughter that are, on average, €90 more profitable than the average animal.

**Table 1.** Relative emphasis (%) of the trait groups included in the Replacement and Terminal indexes.

Traits	Relative Emphasis (%)	
	Replacement Index	Terminal Index
Calving	16%	25%
Beef	39%	72%
Docility	4%	3%
Fertility	23%	-
Milk	18%	-

As with all national breeding objectives, the Euro-Star indexes are constantly revised in light of changing economic outlooks as well as the availability of additional data and greater understanding of new traits. The most recent changes to the Euro-Star indexes include a revision of the genetic evaluation for calving traits with the addition of birth weight and early-life weights as predictors for calving traits.

## Importance of farmer scored traits

Before a new trait can be added to the indexes, data must be available on either the trait itself, for example carcass conformation, or a genetically correlated trait, for example ultrasound muscle depth as a predictor of carcass lean meat yield. To maximise the reliability associated with a trait, data should ideally be available in early life, across both genders and available

at low cost on a large number of animals. However, the volumes of data generated on some key traits remains low; for example, calf weight measured between 150 and 300 days is used to estimate a cow's milk yield but currently the number of calves weighed during this period remains very low (<20%) and this results in low reliability associated with the daughter milk trait within the Replacement Index. To counteract the low quantity of weaning weight data generated currently, ICBF has focused on the collection of a new farmer scored milkability trait. Recent research comparing farmer milkability scores to calf weaning weight has shown that the farmer recorded milk scores are an excellent indicator of the weaning weight of a calf. In addition, the farmer milkability score has been shown to be under genetic control and can, therefore, provide a new predictor for daughter milk. Other examples of farmer scored traits include calving difficulty, weanling quality and cow and weanling docility. Schemes such as the Beef Data and Genomics Programme (BDGP) are focusing on increasing the volume of farmer scored information on new traits such as calf quality, calf vitality, bull functionality and health traits, and once research is completed these traits will be incorporated into the genetic indexes as well.

## Genomic Selection

The performance of any animal across different environments is determined by the genes of the animal. Genes, which are made up of DNA, remain the same throughout an animal's life and are identical in every cell in the body. Therefore, knowing the genes of a calf at birth and how these genes affect performance allow us to accurately predict how that animal would perform in the average environment many years later. This process is called genomic selection. This technology provides a more accurate prediction of how the animal will perform before on-the-ground performance records are available on the animal. Genomic selection has been operational for the Irish dairy industry since 2009 and, through the help of schemes such as the BDGP, the introduction of genomic selection for the beef breeding indexes is being explored. Presently, a calf's Euro-Star Index at birth is based solely on the information of the sire and dam and the reliability is approximately 20%; the introduction of genomic selection will increase the reliability of all traits within the index. This will reduce fluctuations in animal proofs over time and allow farmers to make more informed breeding decisions, which will increase the profitability for the beef sector. Research on the introduction of genomic selection for beef breeds is nearing completion and it is anticipated that genomic selection will be launched for the Irish beef industry in autumn 2016.

## Do the Euro-star indexes work?

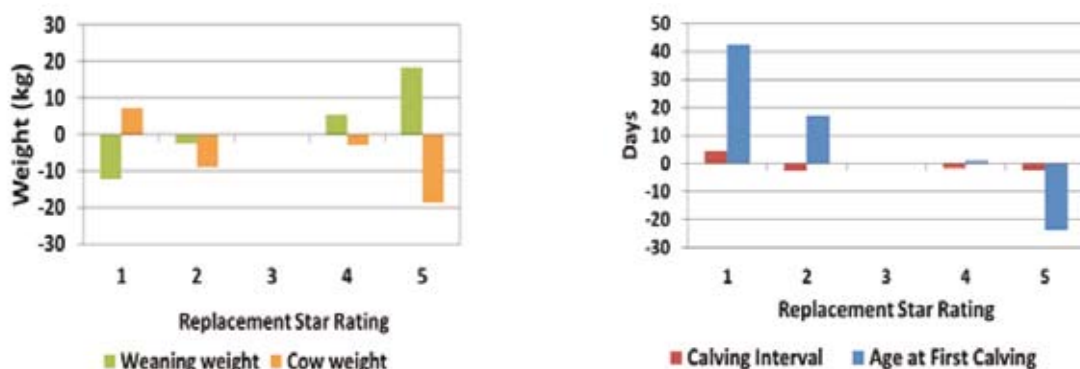
To assess the accuracy and usefulness of the ICBF Euro-indexes, the genetic index of individual animals can be compared to on-the-ground performance of individual animals and their progeny. Teagasc has recently undertaken extensive analysis to evaluate the accuracy of both the Replacement and Terminal indexes using two different datasets.

### *Replacement Index*

Cow and calf performance data were available from 34 spring-calving commercial suckler herds that are participating in a weight recording initiative undertaken by Teagasc in conjunction with ICBF. As part of this initiative weight information was collected on all cows and calves over the summer months in 2015 and will be repeated over the next three years. Cow and calf weight information, as well as data on calving, fertility and other calf performance traits for the last five years (2010 to 2015) on 25,155 cows and their progeny, were used to assess the

usefulness of the Replacement Index in detecting differences in performance between high and low star rated cows.

Results from this analysis show that across a range of maternal traits, cows with high star ratings on the Replacement Index had superior on-the-ground performance compared to low star rated cows. On average, five star replacement index cows were 66 days younger at first calving, and maintained a tighter calving interval (371 days versus 378 days) compared to one star cows (Figure 1). Cows with five star replacement indexes were also more likely to survive to next calving (81%) compared to one star cows (73%). Cows with high Replacement Indexes were on average lighter than cows with low indexes (Figure 1), however, five star Replacement Index cows on average weaned heavier (30 kg) calves compared to one star cows. This resulted in the five star cows weaning proportionally more of their own body weight (36%) compared to one star cows (33%). Cows with high Replacement Indexes were also more likely to produce more calves over their lifetime (+1.18 calves), experience less difficulty at calving (-0.27) and have lower levels of calf mortality (-3.92%) compared to cows with low replacement indexes (Table 2). These results indicate that selection of cows for favourable high Replacement Indexes will result in favourable improvements in cow performance.



**Figure 1.** Average on-farm performance of cows differing in star ratings for the Replacement Index for calving interval, age at first calving (measured in days) and weaning and cow weight (measured in kg). For all traits, three star cows were centred to zero.

As performance of a cow's progeny is also accounted for within the Replacement Index, the performance of subsequent progeny was also analysed in the current dataset. Results show that progeny from cows with high Replacement Indexes were more likely to outperform their contemporaries from cows of low Replacement Index throughout their lifetime. Weanlings from high Replacement Index cows had higher growth rates to weaning (1.21 kg/d for progeny from 5 star cows) compared with progeny from low Replacement Index cows (1.07 kg/d for progeny from 1 star cows). This superior performance was also reflected in their slaughter performance, with progeny from high Replacement Index (5 star) cows slaughtered at an earlier age and at heavier carcass weights compared to progeny from low Replacement Index (1 star) cows (Table 2). No statistically significant differences were detected in carcass conformation score of the progeny of cows of varying star ratings but the conformation score tended to be higher for progeny of cows with lower stars for the Replacement Index (Table 2).

**Table 2.** Average on-farm performance of the progeny of cows differing in star ratings for the Replacement Index for age at slaughter (days), carcass weight (kg) and carcass conformation score (score 1= P- to score 15 = E+).

Replacement Index star	Age at Slaughter	Carcass weight	Carcass conformation
1	629	341	9.07
2	625	344	9.09
3	630	350	9.16
4	632	352	9.09
5	626	355	9.05

Similar analysis was recently undertaken using data from 30 farms participating in the Teagasc/Farmers Journal BETTER Farm Beef Programme comparing performance of five star versus one star Replacement Index cows over a five-year period. Results showed that the five star Replacement Index cows were younger at first calving (58 days), had shorter calving intervals (11 days) and their calves had greater growth rates (1.24 kg/day for calves from 5 star cows versus 1.03 kg/day for calves from 1 star calves; Table 3).

**Table 3.** Number of cows and average Replacement Index (€) for the Teagasc/Irish Farmers Journal BETTER Farm Beef Programme herds for cows differing in Replacement Index star ratings for age at first calving (days), calving interval (days) and calf ADG (average daily gain, kg).

Replacement Index star	No. Cows	Replacement Index (€)	Age at first calving	Calving Interval	Calf ADG
1	458	7	923	389	1.03
2	401	44	912	386	1.10
3	441	64	893	387	1.13
4	575	86	903	382	1.16
5	1,293	133	865	378	1.24

Both these datasets clearly show that selecting high Replacement Index cows will result in greater performance across a range of maternal traits and increase profitability for farmers.

### *Terminal Index*

The Euro-Star Terminal Index for 156,864 animals across 7,301 herds was compared to the animals subsequent slaughter performance. Results from the analysis showed that animals classified as very high genetic merit had superior carcass characteristics compared to animals of lower genetic merit (Table 4). Animals with very high terminal merit were, on average, six days younger at slaughter and produced heavier carcasses (+38.7 kg) than those with very

low merit. In addition, animals of very high genetic merit had superior carcass conformation and less fat compared to animals of lower terminal merit (Table 4). The superior slaughter performance associated with animals of very high terminal merit resulted in these animals obtaining a greater carcass value (€189 greater versus very low terminal merit animals) compared to all other genetic merit groups (Table 4).

**Table 4.** Average slaughter performance for animals categorised as very high, high, low or very low on terminal index for age at slaughter (days), carcass weight (kg), conformation score (score 1= P- to score 15 = E+), carcass fat (scale 1 to 15) and carcass value (€).

Genetic merit group	Age at slaughter	Carcass weight	Carcass conformation	Carcass fat	Carcass value
Very high	744	368.5	8.51	6.14	1409
High	747	354.1	7.33	6.50	1331
Low	746	345.3	6.88	6.75	1288
Very low	750	329.8	6.30	6.96	1222

## Beef Data and Genomics Programme (BDGP)

The four-hour mandatory BDGP training courses are on-going countrywide. Teagasc is the single agency delivering the training course on behalf of the Department of Agriculture, Food and Marine. Participants are given fourteen days written notice of the courses. They begin at 10am and are finished at 3pm. Nominees are also eligible to attend the courses on behalf of the herd owner. Each participant is paid €166 for course attendance. There are six distinct categories covered during the BDGP training course namely: 1. calving details, 2. surveys, 3. genotyping, 4. replacement strategy 5. Carbon Navigator, and 6. general training. There are six videos shown during the course which give real life examples of the different aspects of the BDGP and what it means to participating farmers. All BDGP courses will be finished by 31 October 2016 and each participant will face penalties and/or ejection from the programme if they do not complete the training on time. Another important task which must be completed before the 31st October 2016 is the Carbon Navigator. Each participating farmer must make an appointment with a Carbon Navigator Approved Agricultural Advisor to complete this exercise. The cost of this task is being covered by the Department of Agriculture, Food and Marine so the message to all BDGP farmers is to “get this job done soon”. A full list of carbon navigator approved advisors is available on the Department of Agriculture, Food and Marine website [www.agfood.ie](http://www.agfood.ie).

## Conclusion

Genetic indexes are an important tool that allow beef farmers make more informed breeding decisions and have the potential to increase profitability at farm level. Selection of high genetic merit animals will result in increased performance on traits of economic importance. High Replacement Index animals will deliver more milk, better fertility and last longer in herds. High Terminal Index animals will deliver superior carcass traits at younger ages. Teagasc will continue to work closely with the industry to further enhance beef cattle breeding and ensure that the benefits are clearly seen at farm level.



## Increasing grass utilisation on beef farms

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### Summary

- Profitable beef production in Ireland is based on the provision of sufficient quantities of high quality pasture to produce quality beef at lowest cost.
- Only 10% of grassland farms have optimal soil pH, Phosphorus (P) and Potassium (K) status; this is a major constraint to grass growth on these farms.
- Increasing grass utilisation, farm stocking rate and the number of grazings achieved on the farm are the main drivers of increased grazing efficiency.
- Grazing management factors that increase grass production include spring grazing management, targeting the correct mid-season pre-grazing herbage mass and post-grazing sward height.
- Greater utilisation of early-spring grass is required on drystock farms.

### Introduction

Future farming systems need to be economically and socially sustainable. Ireland possesses significant advantages that place the agriculture sector in a strong position to progress and take advantage of the rising long-term demand for food. The livestock industry produces meat and milk products for some of the highest value and highest specification markets in the world. Our temperate climate and resulting grass production advantage allows us to exploit the competitive advantages associated with grass-based production systems compared with high input systems.

Ultimately, the optimum stocking rate for an individual farm is that which maximises profitability and is dependent on the individual farm's 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 upskill 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. This paper will outline how more grass can be grown and utilised on beef farms.

### Soil fertility management

Improving soils with poor fertility status is essential for productive grass swards. Managing soil fertility is now a major focus of grassland farmers. Approximately 90% of the soil samples

taken from Irish farms are limiting in one of the three major soil nutrients (pH, phosphorus (P) and potassium (K)). The target for both P and K is Index 3 (and also targeting high values within index 3); however, only about 30% of soils are in the agronomically optimum Index 3 range for P and K. Current trends in soil P and K indicates a decline from higher and more productive Index 3 and 4 soils down to low fertility Indexes 1 and 2.

Recent research has shown that soils with P Index 3 will grow approximately 1.5 t dry matter (DM)/ha per year more grass than soils with P Index 1. A longer-term study examining the effect of P fertiliser on grass yield on two low soil P sites showed that low inputs of P (15 kg/ha per year) resulted in total annual yield benefits of close to 1 t DM/ha. Most of the DM yield response in these experiments took place in spring and early summer. Organic manures are the cheapest form of fertiliser available to livestock farmers and therefore, its use must be optimised. The fertiliser value of cattle slurry is equivalent to approximately 5 and 30 units of P and K, respectively, per 1000 gallons (very close to 1 bag of 0-7-30). Cattle slurry is typically applied to grassland areas designated for grass silage production. In the case of "silage paddocks" with low P and especially low K status, the application of slurry without additional applications of inorganic P and K is insufficient.

Soil pH affects the availability and uptake of both major and trace elements by crops. The ideal pH for grass growth, nitrogen (N) release and P and K availability is 6.3. Liming increases the soil pH, stimulates the release of N from soil organic matter and may also increase N supply by increasing white clover growth. Applying lime to increase the soil pH will increase nutrient uptake and DM yield, and improve the long-term persistency of perennial ryegrass and clover in the sward. Recent research illustrates that 5 t/ha of lime applied to a soil with low pH (5.3) increased grass production by approximately 1.5t DM/ha in the following two year period. Previous research on a soil with very low pH (5.3) and old permanent pasture indicated that the application of 7.5 t of lime/ha increased the stock carrying capacity by 20% by the end of the first year and by 100% in the fourth year. The impact on grass DM yield was attributed to the effect of lime on soil organic matter breakdown. Lime application was estimated to be equivalent in benefit to using approximately 60 units/ac (72 kg/ha) of N fertiliser per year.

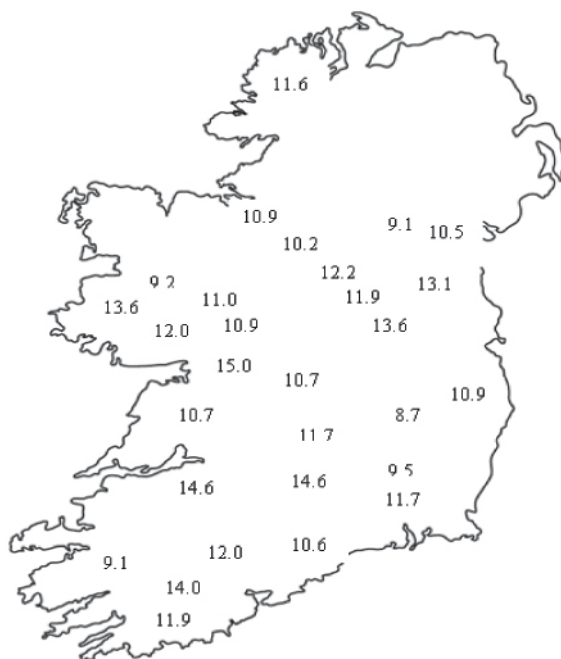
Sulphur (S) is also a key nutrient that needs to be applied as fertiliser, especially on lighter more free-draining soils. Deficiency of S in swards will reduce DM yield by up to 14 - 20% and also reduces the response to N fertiliser.

## PastureBase Ireland

PastureBase Ireland (PBI) has been in operation since January 2013. PastureBase Ireland is a web-based grassland management tool incorporating a dual function of grassland decision supports (spring rotation planner, grass wedge and grass budgeting for both spring and autumn) and collecting and storing a vast quantity of grassland data from dairy, beef and sheep farms in a central national database. At present most farms recording on PBI are dairy farms, with drystock farms accounting for 10-15% of the client base. The data accumulated to date indicate that PBI participating farms have achieved improvements in grass DM production and grazing management.

PastureBase Ireland is informing us that farmers need to have 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 inside the farm gate. Any farm that is dependent on imported feed is exposed in the current volatile market environment. PastureBase Ireland database stores

all grassland measurements within a common structure. This allows the quantification of grass growth and DM production (total and seasonal) across different enterprises, grassland management systems, regions, and soil types using a common measurement protocol and methodology. Background data such as paddock soil fertility, grass/clover cultivar, aspect, altitude, reseeding history, soil type, drainage characteristics and fertiliser applications are also recorded.

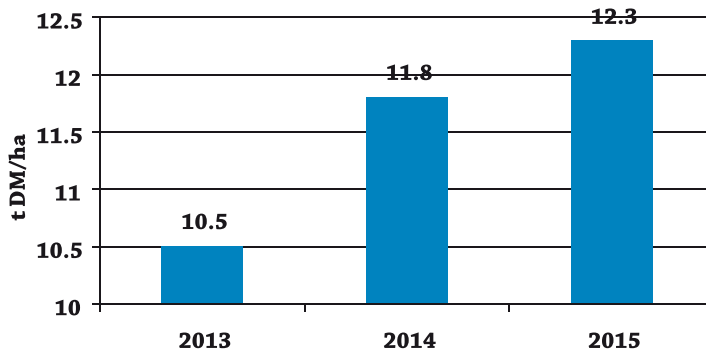


**Figure 1.** Annual grass dry matter production (t/ha) from PastureBase Ireland drystock farms in 2015

## Grassland performance on drystock farms

Figure 1 shows the annual grass DM matter production for drystock farms recording data on PBI in 2015. This map indicates that there was very little effect of location on annual DM production. Figure 2 shows the annual DM production data from a set of drystock farms recording farm covers on PBI across the country from 2013 to 2015. The average annual grass DM production on drystock farms was 12.3 t/ha (2015), which was a 0.5 t DM/ha increase from 2014, which in turn, represented an increase of 1.3 t DM/ha when compared to 2013. The maximum annual DM production for an individual farm in 2014 was 14.6 t DM/ha; in 2015 it was 14.7 t DM/ha. The number of grazings achieved on these farms increased from 5.0 per paddock in 2014 to 5.4 grazings per paddock in 2015, which is a significant increase in grazing DM utilisation.

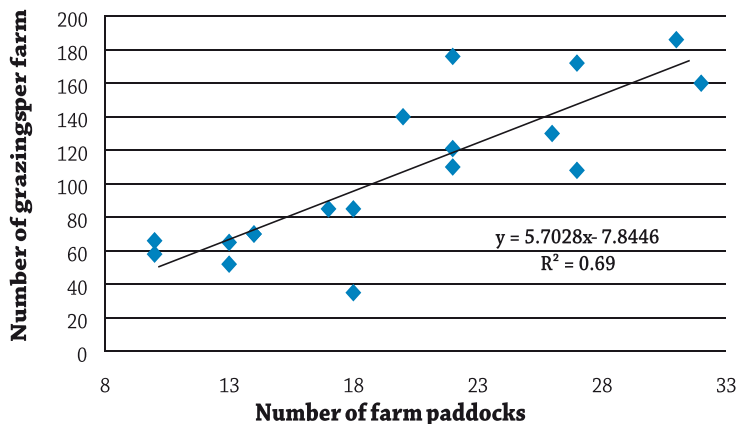
Taking a more in-depth look of why some farms are able to produce high quantities of grass it is clear that achieving more grazings from each paddock during the season is key driver of success. On a high proportion of drystock farms the number of paddocks is inadequate,



**Figure 2.** Annual grass DM production on drystock farms measuring farm cover on PastureBase Ireland (2013-2015).

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 residuals are not achieved, nitrogen application is irregular and, in many cases, pre-grazing yields are too high at grazing time, which results in swards needing to be topped on a number of occasions across the season.

Figure 3 shows the 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 grass control, especially during periods of abundant growth. A key finding from the grazing performance of drystock farms recording on PBI showed the



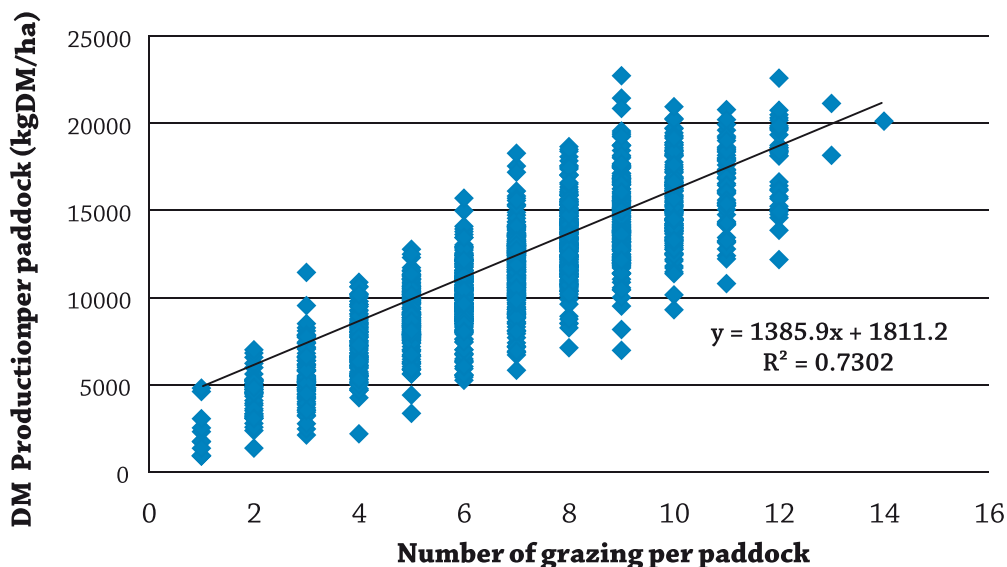
**Figure 3.** The number of paddocks per farm and its association with the total number of grazings per farm

greater the number of grazings achieved, the higher the grass DM production produced ( $r^2 = 0.73$  - Figure 4). Every extra grazing achieved increased annual grass DM production by 1,386 kg DM/ha.

Maximising the number of grazings achieved on each paddock is a very effective method of increasing farm grass utilisation. On many farms, turnout to pasture in spring takes places too late and grazing rotations are too long in the mid-season period. 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 commensurate with three- or four-day residencies.

## Increasing grass growth with early-spring grazing

Maximising grazing in spring (February to early April) has been advocated on grassland farms as subsequent growth rates during the remainder of the grazing season are usually greater in spring-grazed swards compared to swards ungrazed during this period. Previous research comparing early versus late turnout to pasture in spring, found that swards grazed in February subsequently grew more grass in the second rotation compared to ungrazed swards (90 vs. 82 kg DM/ha/day, respectively). More recently, PBI data for 2015 showed that farms which have completed the first grazing rotation in advance of 10 April grew substantially more grass (1,042 kg DM/ha) than farms which finished the first rotation after 10 April (833 kg DM/ha). This is a 15% increase in grass DM production by advancing the finish date of the first rotation. Most beef farms in Ireland are *finishing the first rotation too late* and are losing out on valuable spring grass.



**Figure 4.** The number of grazing achieved per paddock and annual grazing dry matter production



## Summary of spring grassland management performance in 2015 on drystock farms recording data on PastureBase Ireland

- 66% of drystock farms had little/no stock out grazing by 1 March.
- The average area of the farm grazed on 17 March was 20%. Farms with the highest yield of utilised grass had 15% grazed by 1 March and 50% by 17 March (target 40%).
- Only 10% of farms finished the first rotation by 10 April.
- Only 45% of farms were finished the first rotation by 25 April.
- Farms that finished the first rotation before 10 April grew, on average, 200 kg DM/ha more in this period, and 1.1 t DM/ha more annually (12.2 vs. 11.1 t DM/ha), than farms that finished the first rotation after 10 April.

Of major concern is the likely excessive build-up of grass on farms that do not target early-turnout or which finish the first rotation too late. The aim in spring is to increase the proportion of grass in the diet of the grazing animal while at the same time budgeting so that there is enough grass until the start of the second grazing rotation in early April. Spring grazing should start in February/March and continue until early April. The end of the first rotation varies from farm to farm. If turnout to pasture is too late on farms and the first rotation is too long, pre-grazing yields will be too high, grass quality will deteriorate and achieving a post-grazing residual of 4cm will be difficult as utilisation will be reduced. Advantages of finishing the first rotation on time include:

- The first paddock grazed in the second rotation will have an adequate cover for grazing of 8 - 9cm (1000 - 1200 kg DM/ha).
- There will be the recommended 18–21 days of grass on the farm.
- A wedge of grass will be created; highest covers on paddocks grazed early in the spring and lowest covers on paddocks grazed last in the rotation.
- Early-spring grazing increases grass quality in subsequent grazing rotations.
- Increased animal live weight performance through higher suckler cow milk yields leading to heavier weaning weights and higher live weight gains for growing and finishing cattle.

## Conclusion

Focussing on increasing farm soil fertility, grazing management performance, and developing better grazing infrastructure will deliver higher grass production and utilisation on farms. This will provide beef farmers with higher profits in the short, medium and longer term.

In summary, the following are the key issues determining the utilisation of grazed grass on drystock farms:

1. Operating a rotational, paddock-based grazing system.
2. Having good farm infrastructure e.g. adequately sized paddocks, roadway network, etc.
3. Maximising spring grazing – early turnout and finishing the first rotation on time.
4. Addressing soil fertility as required.
5. Recording a farm cover weekly (>25 walks/year).
6. Making decisions weekly on the information generated after each farm cover.
7. Achieving a high number (target >8) of grazings per paddock per year.

## Fertility and health management of suckler cow herds

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### Summary

- Reproductive efficiency is central to economic and environmental sustainability of suckler cow herds and is influenced by a number of factors:
  - ▶ Puberty and age at first calving.
  - ▶ Duration of the post-calving anoestrous interval which is largely affected by cow-calf bonding and pre-calving nutrition.
  - ▶ Heat detection efficiency where AI is used or bull fertility in herds using natural service.
  - ▶ Infectious agents which can negatively impact on cow fertility by increasing rates of embryo mortality and in particular, abortion. Bacterial agents remain the primary cause of bovine abortion in Ireland.
- Preliminary findings from a serosurveillance study of 169 Irish beef herds indicate a prevalence of 71%, 78%, 44% and 5% for leptospirosis, BVDV, IBR and neosporosis in non-vaccinating beef cow herds, respectively.
- A national study of over 300 beef herds documented a herd prevalence of liver fluke of >90%, an infection which can exacerbate the impact of bacterial infections.
- Management practices and biosecurity have an important role to play in optimising fertility through the prevention and control of infectious agents.

### Introduction

Herd fertility and health are two of the main factors determining output and ultimately the profitability of suckler cow herds. In Ireland there is evidence that over 80% of replacement heifers fail to meet the target age at first calving of 24 months; the average calving-to-calving interval is frequently in excess of 400 days and only eight out of every 10 cows produce a calf within in a 12-month period. These statistics do not bode well for the future economic and environmental sustainability of the national suckler cow herd. In this chapter the key elements of fertility and health management of spring-calving beef cow herds will be discussed.

### Reproductive targets for a beef herd

The reproductive and productive targets for a suckler cow herd can be summarised as follows: 1) 365 day calving-to-calving interval; 2) <5 % cows culled annually as barren; 3) >95% of cows calving, wean a calf; 4) heifers calving at 24 months of age; 5) compact calving with 80% of cows calved in 42 days; 6) replacement rate 16-18%; 7) sustained genetic improved of the cow herd for economically important traits relating to reproduction, calving ability and calf weaning weight; and 8) close alignment of calving date with onset of pasture availability in the spring.

There are three key benchmarks that must be achieved in a timely fashion in order to meet the above targets. These are:

- 1) Occurrence and timing of puberty and breeding of replacement heifers;
- 2) Resumption of oestrous cycles post calving; and,
- 3) Breeding and the establishment of pregnancy.

## 1. Occurrence and timing of puberty and breeding of replacement heifers

Replacement heifers represent the next generation of cows in a herd and ideally each year's cohort of heifers should be genetically superior to their predecessors. Significant costs are incurred during the rearing of replacement heifers and it is imperative that they become pregnant early in their first breeding season, encounter minimal dystocia, are successfully rebred to calve again within 365 days, and ultimately, have long (at least 6 lactations) and productive lives within the herd. Data from Grange studies clearly show that delaying first calving from two to three years of age decreases net margin per hectare by 50%, mainly as a result of increased feed costs. Therefore, the target should be to first calve at two years of age. Indeed, within a two-year old calving system, heifers that conceive early during their initial breeding season have a greater probability of becoming pregnant as first calving cows, have greater lifetime production (calf weaning weights), and tend to calve earlier in subsequent years compared to their contemporaries that conceived later as heifers. Hence, age at which puberty occurs, (defined as the developmental stage that supports normal oestrous cycles combined with the ability to become pregnant) will impact on the time of conception in the first breeding season and ultimately lifetime productivity. Additionally, conception rates are typically lower at the pubertal compared with subsequent heats.

There is some variation in the published literature on the threshold proportion of mature bodyweight which heifers must attain before undergoing puberty and absolute weight targets will vary in accordance with breed. In general, it is currently advised that replacement heifers should attain in the region of 65% of mature body weight at the start of the breeding season to ensure that a high proportion are pubertal and eligible for breeding, with a target of 60-70% pregnant after 3 weeks of breeding. However, the concept of 'mature weight' for any particular breed type or crossbred is debatable making it difficult to set clear body weight targets. Thus, in order to generate accurate guidelines on the nutritional management of replacement of replacement heifers for the suckle herd, our group are currently engaged in a large Department of Agriculture Food and the Marine (DAFM) funded project examining the effect of post-weaning (>8 months of age) plane of nutrition in heifers sourced from either beef or dairy herds and sired by either Aberdeen Angus or Limousin bulls on age at puberty and subsequent fertility. The results of this study will be available later this year.

## 2. Resumption of oestrous cycles post calving

Suckler cows are on average much longer calved when they resume oestrous cycles than dairy cows, with average calving to first ovulation intervals of 50-55 days recorded in a number of Teagasc studies. This is almost twice as long as the equivalent interval for dairy cows. Additionally, for first-calving beef cows (heifers) this interval is usually 10-15 days longer than mature cows.

*Cow-calf bonding:* The predominant reason for the long anoestrous (absence of normal oestrous or 'heat' cycles) interval in suckler cows compared to dairy cows, is the strong maternal-

offspring bond that exists between the dam and her calf. This bond is predominately affected through sight and smell. Teagasc studies have shown the “cow-calf bonding effect” is further compounded by having suckler cows in a low body condition score (BCS) at calving. Indeed the effects of low BCS at calving are only partially reversed by placing cows on a high plane of nutrition after calving. Teagasc studies have shown a clear benefit of short-term restricted suckling for shortening the interval between calving and first breeding. While the labour input is significant, many commercial herds in Ireland are successfully implementing this practice for autumn and early-spring calving herds, in particular. For herd owners planning to use calf separation the following is recommended:

- ▶ Commence calf separation and twice daily suckling at day 30 post-calving and continue for two weeks. Ideally keep the calves and cows 50 metres apart. Between 85-90% of cows will exhibit fertile heat within 18-22 days. About 10-15% of cows fail to ovulate in response to calf separation (nutritional anoestrus). It is unlikely that these cows will respond to synchronisation either until such time that their BCS is improved. Calf separation is particularly applicable to late-calving cows and first-calvers. However, it does entail some additional labour.

*Role of nutrition:* From the published literature it is clear that: 1) prepartum nutrition is more important than postpartum nutrition in determining the duration of postpartum anoestrus; 2) energy is the primary nutrient regulating reproduction in female beef cattle and inadequate dietary energy during late pregnancy lowers fertility even when dietary energy is adequate during lactation; and, 3) a BCS of 2.5-3.0 (scale 0-5) will ensure that body reserves are adequate for postpartum reproduction. The reported effects of increased nutrient intake after calving on duration of the postpartum anoestrous interval are inconsistent. However, there is evidence that thin cows at calving and particularly first-calvers and young cows respond to increased postpartum nutrient intake with enhanced reproductive performance although reproductive performance may still be less than adequate. It may well be that a certain level of body fatness may be a prerequisite for occurrence of puberty and resumption of postpartum oestrous cyclicity. A more detailed discussion of the nutritional management of suckler cows and in particular the utilisation of body condition scoring to optimise reproductive efficiency is presented on page 118.

### 3. Breeding and the establishment of pregnancy

In suckler cows, unlike dairy cows, there is no substantial evidence of a temporal decline in conception rate and typical conception rates of 60-70% are achievable to either AI or natural service, unless there are problems with semen quality, AI technique or bull fertility. Indeed, the management of all of these ‘male’ related factors, as well as their potential effects on cow fertility, are comprehensively covered on page 138. Conception rates reach a normal level in cows bred at 60 or more days after calving. However, when cows are bred at 40 days or less after calving, conception rate is usually <40% but it is still advisable to breed such cows once the breeding season has commenced. Additionally, post-calving conception rates are often lower for first-calvers compared to mature cows, which is a reflection of the increased nutritional demands of the young cow for growth in addition to maintenance and lactation requirements. Where AI is used, fertility is highest following insemination at 12-18 hours after heat onset but is not greatly reduced following early insemination. However, late insemination, at 24 hours or later, after onset of standing heat, should be avoided.

## Role of infectious diseases in cow infertility

A number of infectious diseases are known to affect a cow's ability to produce a live calf, breed successfully, and subsequently carry a healthy calf to full term (Table 1). *Brucella abortus* and bovine viral diarrhoea virus (BVDV) are currently the only agents listed that are under statutory control. The Republic of Ireland is now classified as 'brucellosis-free' as no confirmed cases have been reported in the past number of years and the levels of BVD have been significantly reduced.

**Table 1.** Infectious causes of infertility (embryo loss and abortion) in cattle. Those agents highlighted in **bold** have recorded cases of bovine abortion in Ireland since 2008 (DAFM, 2008-2010).

Bacterial	Viral	Protozoan	Fungal
<b>Salmonella spp.</b>	<b>Bovine viral diarrhoea virus (BVD)</b>	<b>Neospora caninum</b>	<b>Aspergillus fumigatus</b>
<i>Leptospira</i> spp.	<b>Bovine herpesvirus-1 (IBR)</b>	<i>Tritrichomonas fetus</i>	<b>Mucor spp.</b>
<b>Arcanobacterium pyogenes</b>	<i>Bluetongue virus</i>	<i>Toxoplasma gondii</i>	<i>Mortierella wolffii</i>
<b>Bacillus licheniformis</b>	Epizootic bovine abortion	<i>Anaplasma marginale</i>	
<b>Listeria monocytogenes</b>	Akabane virus		
<b>Campylobacter fetus</b>	Schmallenberg virus		
<i>Coxiella burnetii</i>			
<i>Chlamydomphila</i> spp.			
<i>Haemophilus somnus</i>			
<i>Ureaplasma</i> spp.			
<i>Brucella abortus</i>			

(Adapted from Givens and Marley, 2008)

## Fertility-related infectious diseases in Ireland

An infectious agent can impact cow fertility in a number of ways, including:

- Affecting the uterine environment post-calving (endometritis);
- Resulting in embryonic death following breeding. Embryonic death can be described as termination of pregnancy and loss of the embryo prior to day 42 following insemination, with the cow returning to service; or,
- Resulting in abortion. Abortion can be described as termination of pregnancy and loss of the foetus post day 42 following insemination.

The Regional Veterinary Laboratories in Ireland carry out a significant number of foetal examinations on an annual basis and the most common infectious causes of abortion since 2008 continue to be *Salmonella dublin*, *Leptospira interrogans* serovar *hardjo*, and *Neospora caninum*. *Arcanobacterium pyogenes* and *Bacillus licheniformis* also record significant levels of abortion but these tend to occur on a more sporadic basis and preventative measures are difficult to apply, although *B. licheniformis* thrives in spoiled feed and forage. Embryo losses due to infectious disease are more difficult to quantify as investigations tend to be carried out at



farm-level and are not reported nationally. Thus, in order to address this void in information, Teagasc led a large DAFM funded suckler cow herd prevalence study ('BeefCow' programme) which incorporated investigations into BVD, IBR, *L. interrogans* serovar *hardjo* and *N. caninum* in order to provide information on the potential impact of these diseases on herd fertility. Additionally, although not a direct cause of abortion, liver fluke can exacerbate the impact of certain infection disease (i.e. salmonellosis) on farm. Many international studies are also on-going which are investigating the impact of liver fluke infections on overall cow fertility and such investigations are also planned over the course of the 'Flukeless' programme, led by Teagasc Moorepark. It is important, therefore, not to disregard the impact parasitic disease may have on herd fertility. A brief summary of the two aforementioned national on-farm studies is outlined below.

## 'BeefCow' study

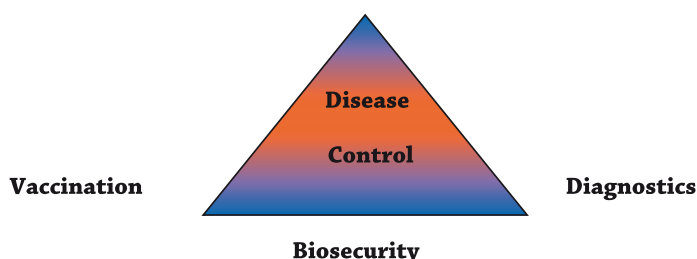
In the summer months of 2014 and 2015, almost 6,000 cows from 169 spring calving suckler cow herds across the island of Ireland (32 counties) were blood sampled to measure the levels of herd exposure to *Leptospira* species, BVDV, bovine herpesvirus-1 (BoHV-1 (causative agent of IBR)) and *N. caninum*. A comprehensive survey was also carried out to determine the vaccination policy undertaken by each study farmer. Preliminary findings from the study indicate exposure to *Leptospira* species, BVDV, BoHV-1 and *N. caninum* in 71%, 78%, 44% and 5% of non-vaccinating suckler cow herds. Some practical steps that can be taken to reduce the risk of exposure to these infectious diseases is outlined in the disease specific section below.

## 'Flukeless' study

A total of 250 beef herds were investigated for exposure to liver fluke in winter 2014/2015. Participating herds were selected on the basis of geographic location and herd size in order to best represent the distribution of beef herds nationally. Based on antibody testing of 6-7 cows in each herd, over 90% of herds and approximately 65% of cows sampled were positive for liver fluke. These very high levels of liver fluke exposure require increased control at farm level in order to reduce the impact of this disease on productive and reproductive efficiency.

## Steps in taking control of infectious diseases

The following three steps are the critical components in achieving control of infectious diseases on beef farms (Figure 1);



**Figure 1.** Components of an on-farm health planning and disease control programme

### Step 1: Implementation of biosecurity

Biosecurity is the single most important contributor to the prevention of infectious diseases and subsequent losses on a farm. The higher the level of a particular disease in a country

(prevalence of a disease), the stricter the biosecurity measures required to reduce the risk of disease introduction. Based on results from the 'BeefCow' and 'Flukeless' studies, leptospirosis, BoHV-1 and liver fluke present significant risks and biosecurity should be aimed at minimising their spread.

Implementation of a strict closed herd policy is the critical component of disease control. A closed herd policy (i.e. no cattle movement, including bulls, onto the farm) will block the direct importation of disease onto a farm. If at all possible, a suckler herd should aim to remain a closed herd although this is not as easily achieved compared to dairy herds.

As disease transmission can also occur by means other than purchasing an infected animal, beef farmers should aim to implement as many of the following procedures as practically possible:

- Maintain stock-proof and disease-proof (3 meter gap between neighbouring farms to prevent nose-to-nose contact) boundaries on all land parcels.
- Use footbaths – need to be well-maintained (cleaned and re-filled regularly).
- Signage should be used to maintain awareness of biosecurity on farm.
- Aim to use separate disposable needles for each animal when administering medications or taking samples.
- Separate rectal sleeves should be used for each animal when scanning, examining or treating cows.
- Importation of animal products (slurry, colostrum) should be avoided.
- Vehicles visiting the farm should be kept at a safe distance from animal areas e.g. housing, holding yards, roadways.

It is important to recognise that an animal health plan once implemented will act as an insurance policy against infectious diseases. It is not a guarantee that a herd will remain disease free but it will significantly reduce the risk of disease introduction into a herd.

### *Step 2: Diagnostic testing*

The usefulness of diagnostic testing on Irish beef and dairy farms is often underestimated and besides routine annual screening of herds for TB and BVDv, many beef farms do not carry out any additional routine herd health screening. Use of sentinel animals (i.e. indicator animals tested at least annually) can prove a useful means to detecting changes in herd disease status, especially in the case of smaller herds. Such a strategy can be used to provide an on-going insight into the disease status of a herd and provide valuable supporting information for the implementation of both biosecurity and vaccination protocols.

### *Step 3: Vaccination*

It would appear that the up-take of vaccines by Irish farmers is much greater than the up-take of either biosecurity or diagnostic testing. Vaccines play a hugely important role in the control of many infectious diseases. Their use, however, without the supporting knowledge provided by diagnostic testing and the implementation of a biosecurity plan, could potentially undermine their effectiveness in a disease control programme. Misuse of vaccines is also a significant contributing factor to the failure of a vaccine programme. Vaccine instructions must be read in their entirety and the number of injections administered, dosage and correct vaccination timing adhered to, in order to achieve successful vaccination. Vaccines should be viewed as a component of a control programme but not as the sole means of disease prevention within a herd. Over-reliance on vaccination without the backup of proper management, biosecurity and diagnostics should be avoided. Consult with your vet on how best to implement a herd health program to protect your herd.





# Technology Village:

**Teagasc / Irish Farmers Journal  
BETTER Farm Beef Programme**

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# Lessons learned from the Teagasc/ Irish Farmers Journal BETTER Farm Beef Programme

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## Summary

- The gross margin of farms participating in the BETTER Farm Programme increased by 53% over the course of the programme or €18,655 per farm on average.
- Stocking rates increased from 1.98 to 2.27 LU/ha from 2012 to 2015.
- Gross output increased by 22% and variable costs increased by 8% over the course of the programme.
- Grass growth on the programme farms averaged 10.3 t/DM/ha in 2015.
- BETTER Farm herds achieved a 382-day calving interval versus the national average of 407 days.
- Herd health improvements contributed to higher levels of output, reduced vet bills and lower labour requirements.

## Introduction

The Teagasc/Farmers Journal BETTER (Business, Environment and Technology through Teaching, Extension and Research) farm beef programme was established in 2009. The objective was to improve the productivity and profitability of beef farming in Ireland. To date, the programme has comprised of two phases. The first three-year phase ran from January 2009 until December 2011 with Phase 2 running from 2012 to 2016. The objective of this article is to document changes in financial performance, grassland management, breeding and herd health for the participating farms over this period.

## BETTER Farm financial management

*Comparison with average farm systems in Ireland*

Analysis was carried out on the annual trends in output, costs and profitability for the suckler farm participants in the BETTER farm programme for the years 2008 to 2014. To provide some context, performance was compared with the average profitability of suckler farms in Ireland as represented by the National Farm Survey (NFS) annual reports (cattle rearing category). All input and output costs were corrected for annual price changes based on the CSO price index and all subsidies were excluded.



Farm size, suckler cow numbers, number of livestock units (LU) and stocking rate were greater on the BETTER farms than NFS. However, the effect of participation in the BETTER beef farm programme is exemplified by the annual change within each of these variables. Farm size decreased by 19% from 2008-2014 on the BETTER farms, reflecting the introduction of predominantly smaller farms in Phase 2 of the programme. In comparison there was a 30% increase reported in the NFS. Total variable costs (TVC) increased on both groups of farms, with an average increase in costs of 32% on the BETTER farms compared to 17% on NFS farms from 2008-2014. Total fixed costs (TFC) decreased by 5% on the BETTER farms compared to an 8% increase on NFS farms. Extreme adverse weather conditions in 2012-2013 increased feed costs, but the cost increase was greater on the BETTER farms (53%) compared with NFS farms (20%). From 2012 to 2013, TVC continued to increase on NFS but declined on the BETTER farms. This reflects improved planning of forage requirements on the BETTER farms, where fodder purchases were made in 2012, thus bearing much of the cost of the prolonged winter of 2012/13 in advance. In contrast, most of the costs of fodder shortages on NFS farms were made in 2013 when the shortage became acute. Gross output value on the BETTER farms was consistently more than double that achieved on NFS farms (44% vs. 20% for the BETTER farms and NFS, respectively). Gross margin increased by 58% on the BETTER farms compared to a 23% increase for NFS farms. Net margin increased from €49/ha to €384/ha on the BETTER farms over the seven year period, while NFS remained loss-making in all years.

## Financial summary

Table 1 outlines how gross margins have improved on *all BETTER Farms* since the beginning of Phase 1 of the programme. For the phase 2 participants, average gross margin has increased from €675/ha in 2012 to €1029/ha in 2015. At a production systems level, gross margins were: €715/ha for weanling producers (compared to €363/ha nationally); €785/ha for store traders (compared to €572/ha nationally); and, €1241/ha for suckler to finishing (compared to €532/ha nationally). Within the finishing systems, farms incorporating under 16 month bulls performed best in 2015 with a gross margin of €1464/ha followed by suckler to under 20 month bulls at €1220/ha. Suckler to steer finishing systems achieved a gross margin of €1083/ha.

**Table 1.** Average gross margin (€/ha) for farms on the BETTER farm beef programme

	2009	2010	2011	2012	2013	2014	2015
Gross margin	286	405	553	675	579	837	1029

## BETTER Farm breeding

Maximising output on suckler farms starts with maximising output per cow. The goal on every farm is to produce a live calf every year, of good quality, achieving a good weight for age. Over the course of the programme the target was to achieve 0.95 calves per cow per year. The participants averaged 0.92 calves per cow in 2015, just under the target, while the national average stands at 0.82 calves per cow per year. A critical component of producing a calf per cow annually is to have a calving-to-calving interval of 365 days. In 2015, the national

average for the suckler herd in Ireland was 407 days, while the average across the BETTER farm programme was 378 days. The average calving interval in 2015 varied greatly across the BETTER farms, ranging from 355 to 412 days. In comparison, in 2012 the range was from 342 to 441 days.

To achieve high levels of output and production efficiency, minimal levels of calf mortality are required. Targets are to have calf mortality under 2.5% at birth and under 5.0% at 28 days. The BETTER farm participants had 2.0% calf mortality at birth and 4.5% calf mortality at 28 days in 2015. In comparison, the national average was much higher, with 4.7% mortality at birth and 6.0% mortality at 28 days. The average number of calvings per cow in the programme was 4.3, which is on par with the national average. This figure varied from 3.9 to 5.5 between the BETTER farms in 2015. In 2012 the variation was greater, ranging from 2.6 to 6.2 between the farms.

Regardless of when the calving season starts, a key focus is to keep the calving pattern to a maximum of 12 weeks. A tight calving pattern allows for easier management of livestock, reduced labour, less groups of stock and potentially less disease problems. On most of the BETTER farms there is more focus and attention to detail given to calving pattern. Calving is now compacted into 12 weeks compared to a much more widespread calving pattern previously.

Heifers calving at two-years old are more productive over their lifetime (more calves produced) resulting in increased output. Compared to calving heifers at older ages, stocking rate is reduced and numbers of grazing groups of stock and costs are reduced. The number of BETTER Farm participants calving heifers at 2 years of age has increased significantly; less than 25% of heifers calved between 22 and 26 months of age in 2012, compared to 43% in 2015. In comparison, the national average remains low with only a modest 2% increase, from 16% to 18%, in this period.

## **BETTER Farm grassland management**

Planning for early-spring grass starts the previous autumn by closing up paddocks in rotation from mid-October using the '60:40 Teagasc autumn planner'. Similarly, the '40:60 Teagasc spring rotation planner' is used for the first grazing rotation to ensure that farmers have sufficient grass covers on the farm for the second rotation. Using a rotational grazing system maintains grass quality throughout the year and is an effective method to grow more grass. However, it is essential that the farm is walked on a weekly basis to measure grass growth and to assess the supply of grass. This is one of the most important aspects of grassland management as it allows the farmer to budget grass to maintain enough grazing days ahead, good utilisation and ultimately maintain a highly digestible leafy sward. Grass budgeting using the "grass wedge" will identify if there is a shortage or surplus of grass coming and will allow the farmer to react in advance. The target pre-grazing yield is 1,300-1,600 kg DM/ha (8-10cm) and the objective is to graze paddocks down to 4 cm to ensure good utilisation.

Identifying poor-performing paddocks and implementing a reseeding programme is very important to maintaining productive swards. Swards with a high content of perennial ryegrass are capable of growing more grass during the year which permits higher stocking rates, and producing more digestible herbage which results in greater animal lightweight gain. Soil fertility is the foundation of grass production and plays a key role during spring growth. Target spreading slurry and compound fertilisers to low index soils and maintain soil pH at 6.3-6.5.

Weekly grass measurements are recorded by farmers to closely monitor grass growth and

thus, aid in effective grassland management decision-making. On average, grass growth was 5% lower across the BETTER Farms in 2015 compared to 2014, although 2014 was an exceptional year for grass production with very high annual yields recorded on the BETTER farms. The south-west and south-east regions had the largest decrease in grass growth primarily owing to lower growth rates in spring and the dry weather in June of 2015. Farms in the north-east and north-west experienced similar grass growth in 2015 compared to 2014. On average the BETTER farmers grew almost 10.5 t DM/ha of grass in 2015 with a regional breakdown as follows: south-west, 12.5 t DM/ha; north-east, 10.0 t DM/ha, south-east 9.7 t DM/ha; north-west 9.4 t DM/ha.

## **BETTER Farm herd health**

During both phase 1 and phase 2 of the BETTER Farm programme, herd health has remained a key focus area due to its important impact on animal reproductive and liveweight performance.

In phase 1, BVD eradication was targeted on farms and from the 14 herds that used the 'ear notch' test to detect PIs, 32 PI animals were found, with 10 PI animals in the most severely affected herd. Involvement of the local veterinary practitioner, the Department of Agriculture and the Marine Regional Veterinary Laboratories and Animal Health Ireland was essential in addressing this issue on programme farms.

During Phase 2, the programme has focused on areas such as liver and rumen fluke. Farmers in the programme carried out faecal sampling at housing. Tests were carried out on the samples for both rumen fluke and liver fluke and winter dosing plans were based on these results. Cattle showing negative or low infestations of fluke were left untreated and tested again subsequently to determine if any infestation had built up in the interim, while cattle showing positive or highly positive results were treated with a suitable product.

Each farmer took a pooled sample of 5 faecal tests from each group of stock on the farm, e.g. cows, weanlings, finishers and sent them to be tested. Results showed that there were generally lower levels of liver fluke than rumen fluke. The farms in the north-west region showed a higher level of rumen fluke than the southern region leading to a greater number of those farms treating stock for rumen fluke.





# **Technology Village:**

## **Feed to Meat**



## Grass silage for beef production

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### Summary

- Farms feeding multiple classes of stock over the winter period will likely need silage at various quality levels. A specific farm plan will help to achieve this.
- Soil pH, phosphorus and potassium deficiencies are major limitations to improving silage yield and quality targets. Develop a fertiliser application plan based on soil test results.
- Reseeded swards, tight grazing pre-closing, adequate N application, and cutting at the correct grass growth stage are key elements to maximizing silage quality for a given DM yield.

### Introduction

Grass silage is an important part of the annual feed budget for beef production systems, accounting for up to 25-30% of total feed dry matter (DM) consumed on a typical drystock farm. As a standalone feed it can be quite expensive to produce (€125 to €160 per tonne DM), however when taken as part of an integrated grazing system, well-managed grass silage is cost-competitive relative to concentrates and alternative forages. The principal management challenge for beef producers is to balance the dual objectives of having adequate yield of silage DM while meeting feed quality targets for good animal performance.

### Defining targets for grass silage production

The three key elements to cost-effective grass silage production are:

1. High grass DM yields for first-cut and subsequent cuts, with high total annual grass yield (>14.0 tonnes DM/ha). Guideline yields are 4.8 t DM/ha and up to 6.2 t DM/ha for silage harvested in mid-May and early June, respectively.
2. Appropriate feed quality for the class of livestock to be fed. This is best measured as digestibility of the crop DM (DMD); protein content is also important and is positively associated with DMD. Dry suckler cows can be adequately fed on 67-68% DMD grass silage. For growing/finishing cattle and suckler cows in early lactation, the target is to have silage at 72-74% DMD or higher.
3. Clean, stable, feed with high intake characteristics. This is achieved through good fermentation and can be assessed from silage pH (3.9 to 4.2 for un-wilted crops), ammonia (target less than 9%), and lactic acid (target over 8%) content.

Grass DM yield at harvest is the single most important factor determining the cost per tonne of silage in the pit. Fixed costs per hectare such as land charges and contractor fees are diluted over the extra tonnage, and so too are some of the variable costs associated with fertiliser and slurry applications. This, coupled with the objective of building adequate feed reserves for the winter, has meant that silage quantity rather than quality is often given priority on beef farms. National surveys of first-cut grass silage analysis results for Teagasc beef clients in 2014-2015 bear this out, with an average DMD of 65%, and a range from 58% to 77%. But is there any real value to targeting better silage quality for most beef herds? And is it worth losing DM yield to achieve it?

## The benefits of quality silage in beef production systems

The potential benefit of improving grass silage DMD depends on the mix of livestock on the farm over the winter period. While 'national average' silage is suitable only for dry suckler cows requiring zero body condition score gain, farm systems requiring higher animal performance stand to benefit from raising silage DMD by at least 6-7 percentage points above this level. This was demonstrated in a study conducted at Teagasc Grange (Table 1) which measured intake and live weight gains for cattle offered silages with a range of DMD values. Results showed that cattle fed high quality silage (75% DMD) gained approximately 0.3 kg more live weight per day compared to those fed silage at national average DMD (65%). The extra performance was due to a combination of higher daily DM intake (DMI) and greater feed energy value per kg of silage DM.

**Table1.** Effect of silage quality on silage intake and daily weight gain in growing cattle

DMD %	First cut silage quality			
	75	70	65	60
Harvest date	20 May	2 June	15 June	28 Jun
Silage yield (t DM per ha)	4.8	6.0	7.0	7.7
Dry matter intake (DMI) (kg/day)	9.0	8.3	7.6	7.0
Liveweight gain (kg/day)	0.83	0.66	0.49	0.31
Carcass gain (kg/day)	0.51	0.39	0.27	0.15
Feed efficiency (DMI/kg carcass gain)	17.6	21.1	28.1	46.7

The consequences of feeding the higher quality (75% vs 65% DMD) silage at farm level would include approximately 40 kg extra live weight gain over a 150-day housing period, a 2.0 to 2.5 kg reduction in daily concentrate intake for similar daily gain, and/or a shorter final finishing period. Interestingly, the efficiency of carcass gain per kg of DMI was also significantly improved with higher DMD silage, delivering potential environmental as well as economic advantages.

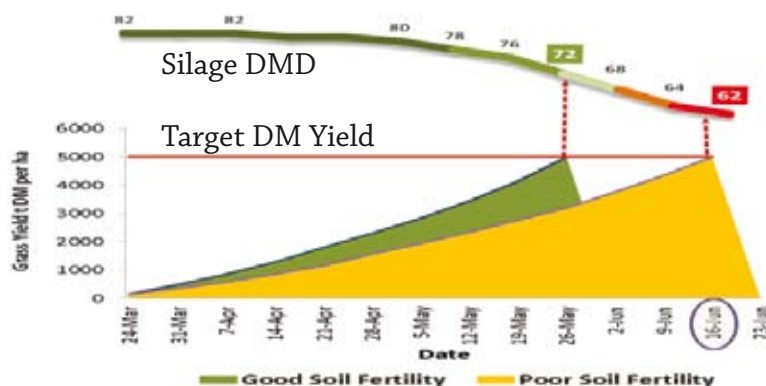
## Finding a balance between yield and quality

Given the significant risk of excess body condition gain for late gestation suckler cows fed high quality silage, it is clear that beef farms with a mix of livestock types (e.g. dry suckler cows, weanlings and finishing cattle) will also have a requirement for silages of varying DMD levels. In the study outlined high DMD silage was produced by cutting in mid-May when grass had high leaf content, while lower DMD silage was produced by delaying cutting into June when grass had become stemmy after seed head emergence. Therefore, while the objectives of good DM yield and excellent preservation remain consistent, target DMD should dictate the optimum stage of grass maturity at which to harvest the crop. The reality for beef farms feeding varied livestock types over the winter is that no single cutting date is suitable for all stock. A simple silage management plan that takes this into account can be developed for the farm, using the following steps:

- 1- Define the highest quality silage required on the farm first.
- 2- Estimate the total quantity of this silage needed.
- 3- Calculate the area of first and subsequent cuts needed to produce this silage.
- 4- Mark on the farm map and set targets for spring grazing, fertiliser, cutting date.
- 5- Manage the remaining area to produce silage of standard quality.

Flexibility is needed around cutting date management, and each farm should develop a plan that suits its own scale, facilities, and stock type. For example, a farm carrying spring-calving sucklers plus some finishing cattle may take an early-cut of high DMD bales in mid-May on 20-30% of silage area, with the remainder of first-cut taken at 67-68% DMD in early June for feeding to dry cows.

But what about the apparent loss in yield associated with higher quality silage? It is a common view that silage quality must come at a direct cost to 'bulk in the pit'. This is not entirely accurate, as the principal factors driving grass yield - soil phosphorus (P) and potassium (K) status, soil pH, reseeded ryegrass swards, nitrogen (N) application rate - also drive quality because they facilitate cutting of high DM yields before grass heading date. This point is illustrated in Figure 1; it shows a well-managed sward on high fertility soils reaching target DM yield by 25 May. A sward on poor fertility soils takes 2-3 weeks longer to reach the same yield by which time DMD has fallen significantly. Delaying cutting in this manner would actually reduce total utilisable feed energy harvested per ha.



**Figure 1.** Effect of soil fertility status on first-cut harvest date and silage DMD

Furthermore, the sward on high fertility soil has 2-3 weeks extra recovery time after first-cut, resulting in improved second-cut silage yield and quality, and perhaps additional autumn grazing. Management decisions around silage yield should therefore be made on the basis of meeting DMD targets and improving annual grass tonnage per hectare, rather than focussing solely on the bulk of an individual cut.

## Management guidelines for cost-effective grass silage production

**Grazing in spring:** To achieve good quality silage in May, it is essential to graze to <4cm residual in February/March before applying fertilizer for silage. A similar effect can be achieved by tight grazing with young stock in late autumn. However, swards with yellow/dead material must be grazed off otherwise silage DMD may be reduced by up to 6-7 percentage points. Silage ground re-seeded the previous autumn should have been grazed at least twice before closing for silage.

**Fertiliser and lime:** The first step to improving silage yield and quality on most beef farms is to take soil samples and develop a field-by-field fertiliser plan based on the P, K and lime requirements (Table 2). Treat P and K separately as silage fields may be adequate for one nutrient but be lacking in the other. Reduce the N application rate by 20-25 kg per ha for old pastures or if the field was grazed rather than cut the previous year. Soil pH is often the first limiting factor for silage yield so ensure the target pH 6.3 is met. Apply lime in summer/

autumn but avoid spreading for 3-4 months before cutting as it may adversely affect the fermentation process.

**Table 2.** Fertiliser nutrient application rates guidelines for first cut silage (kg/ha)

Soil Index	1	2	3	4
P required	40	30	20	0
K required	175	155	125	0
N required	125			
Sulphur required	12-14 (10% of N applied)			

*Timing of silage cutting date:* Swards should be managed such that good grass DM yields (4.8 to 5.0 t DM) are present at or before grass heading date. A decision can then be made whether to harvest at high DMD or delay beyond heading date to increase yield (to >6.0 t DM per ha) of a maintenance-level feed. Timely fertiliser N application and closing is important in this regard. A useful guide for fertiliser N is that grass uses 2.5 kg N (2.0 units) per day on average, so final N should be applied approximately 50 days before planned cutting date. However, the crop may still be safely harvested sooner depending on nitrate and sugar levels. If weather conditions are otherwise suitable, test the grass crop rather than sticking rigidly to the '2-unit rule'. Wilting the crop to >28% DM aids preservation if nitrate readings are high.

*Achieving good preservation:* Good preservation occurs when lactic acid bacteria present on the grass crop ferment available sugars to lactic acid. This causes a decline in pH which preserves the feed value of the stored silage. High available sugars, low buffering capacity and air-free (anaerobic) conditions are necessary for achieving good preservation. Grass sugars content is more critical to good preservation than nitrate readings. Ideal conditions for high sugars are ryegrass swards, dry sunny weather, cool nights and mowing in the afternoon. Add a sugar source (e.g. molasses) if the opportunity for cutting is there, but Brix (sugar) readings are low. Under good ensiling conditions, there is no clear benefit to using additives. Adding inoculants (bacteria, enzymes) will not significantly improve feed value if the standing grass crop is of poor quality. Where wilting is likely to be of benefit, reaching the target DM of 28-32% is a function of swath type and duration of drying. There is no animal performance advantage to wilting beyond 32% DM.

*Reseeding:* Productive silage ground must have perennial ryegrass swards. Old permanent pasture is less responsive to fertiliser nutrients for first-cut crops, leading to delayed harvest and poor DMD. Lower sugar content makes preservation more difficult. The decision to reseed should be based on sward composition and performance. A rule of thumb is that silage ground should be reseeded every 8-10 years (5-6 years for multiple cut systems). Many farms do not reach this target, especially if silage ground is on short-term lease. Reseeding is unlikely to be successful if soil fertility and post-emergence management to promote tillering and weed control are lacking.

*Managing DM losses:* Reducing DM losses at ensiling and feed-out is often overlooked as a potential means improving efficiency. These losses range from 15-30% of standing crop DM. This can add significantly to the cost per tonne of silage fed and increase the requirement for purchased feed. The main sources of DM loss include poor aerobic stability (poor fermentation), failure to seal and maintain pits/bales fully, excessive exposure to air across the silage pit face, and waste at the feed barrier.

## Concentrate feeding for growing and finishing cattle

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### Summary

- Small improvements in feed (cost) efficiency can have a relatively large influence on farm profitability.
- Increasing the level of concentrates in the diet reduces forage intake and increases live weight and carcass weight gains, although at a diminishing rate.
- Subsequent compensatory growth at pasture diminishes the advantage of concentrate supplementation of young cattle.
- High digestibility grass silage with moderate concentrate supplementation can sustain a large proportion of the performance achieved on high concentrate diets.
- Feeding management is more important when feeding concentrates *ad libitum* than as a supplement.
- Comparisons of feedstuffs should be based on their net energy (& protein) values.

### Introduction

Due to the considerably lower comparative cost of grazed grass as a feedstuff, beef production systems should aim to increase animal output from grazed grass. Nevertheless, the main feed costs on beef farms relate to indoor (winter) feeding periods, and especially feeding of finishing cattle. This means that even small improvements in feed (cost) efficiency at these times has a relatively large influence on farm profitability. For example, within grass-based, suckler calf-to-beef steer systems on research farms, grazed grass, grass silage and concentrates account for 66%, 27% and 7% of the annual feed budget, respectively. When this feed budget is expressed in terms of cost (land charge included), the outcome is very different: grazed grass, silage and concentrates account for 44%, 39% and 17% of the total annual feed costs, respectively. 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 and concentrate as efficiently and at as low a cost as feasible.

### Feeding concentrates: key principles

The role of concentrates is to make up the deficit in nutrient supply from forages in order for cattle to reach performance targets. Indeed, in situations where there is a shortage in winter supplies of forage, it may be better to buy concentrates and feed less forage rather than to purchase expensive low-quality forage. Comparisons of feedstuffs should always be based on their net energy (& protein) values on a dry matter (DM) basis. It is important to ensure that adequate levels of an appropriate mineral/vitamin mix are included in the ration.

Dry matter digestibility (DMD) is the primary factor influencing the nutritive value of forage and consequently, the performance of cattle. Low DMD forage means higher



levels of concentrate supplementation have to be used to achieve the same growth rates or performance (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. Production response to concentrate supplementation is higher with forages of lower DMD and in high growth potential animals. Animal response to concentrate supplementation at pasture primarily depends on the availability and quality of pasture and level of supplemented concentrate. 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 primarily depends on animal production response (kg gain/kg concentrate), forage substitution rate and the relative prices of animal product and feedstuffs.

## Concentrate feeding: indoors

### Weanling cattle

To minimise feed costs and exploit subsequent compensatory ("catch-up") growth at pasture during the following grazing season, live weight gains of 0.5-0.6 kg/day through the first winter is acceptable. Due to compensatory growth, there is little point in over-feeding weanlings during the first winter. However, cattle growing too slowly (<0.5 kg/day) during winter will not reach target weights. This target animal performance level 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). Even high quality grass silage is incapable of sustaining 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 ~0.33 kg concentrate daily to sustain performance in finishing cattle. Concentrate supplementation rates for finishing steers to achieve ~1.0 kg live weight/day with grass silage varying in DMD are shown in Table 1. Correspondingly, the supplementation levels recommended in Table 1 should be reduced by about 1.5 to 2.0 kg for finishing heifers (lower growth potential) and increased by about 1.5 to 2.0 kg for finishing bulls (higher growth potential). Where silage DMD is poor (e.g. 60%) and/or 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
Weanlings	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 type**

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.

### *Supplementing grass silage for growing cattle*

Two recent experiments at Teagasc, Grange examined the effects of replacing rolled barley (i.e., starch-based feed) with soya hulls (Experiment 1) or citrus pulp (Experiment 2), (i.e., digestible fibre-based feeds) in a concentrate supplement on intake and performance of young growing suckler-bred male weanling cattle offered grass silage to appetite. In Experiment 1, they were offered 1.7 kg DM, once daily, of one of two concentrate supplements: barley/soyabean-based (862 g rolled barley, 60 g soya bean meal, 50 g molasses, 28 g minerals and vitamins/kg) and soya hulls-based (933 g soya hulls; 50 g molasses; 17 g minerals and vitamins/kg). In Experiment 2, they were offered 1.6 kg DM, once daily, of one of two concentrate supplements: barley/soyabean-based (same formulation as above) and citrus pulp-based (855 g citrus pulp, 80 g soya bean meal, 53 g molasses, 12 g minerals and vitamins/kg). Concentrates were prepared as coarse mixtures and formulated to have similar concentrations of protein (PDIE) 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. Implications are that beef farmers have the opportunity to source alternative (cost-effective) feed ingredients as supplements to grass silage.

### *Concentrate feeds for growing-finishing cattle*

Studies at Teagasc, Grange showed that carcass weight gains and efficiency of feed conversion to carcass were similar for rolled barley and wheat offered as supplements to grass silage. In addition to cereals, a wide variety of other feed ingredients are available.

Research at Teagasc, Grange has also shown that cattle offered concentrates formulated to have similar energy and protein levels but contrasting feed ingredients had similar intake, growth, feed efficiency and carcass traits. Ingredients ranged from, rapidly fermented starch (barley-based), to slowly fermented starch (maize-based), to rapidly fermented starch + fibre or fibre only (pulp-based) and, were offered either as a 5 kg/day supplement to grass silage or *ad libitum* (plus 5 kg fresh weight grass silage daily). This means that net energy (and protein) levels of beef rations are more important than ingredient content *per se*.

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-based concentrate ration with maize meal (plus sufficient soyabean meal to ensure adequate dietary protein) on the performance of young dairy bulls and suckler bulls offered concentrates *ad libitum* over 170 and 86 days, respectively, was evaluated at Grange. In the dairy bull study, intake was higher for the maize meal-based ration but there was no difference in carcass weight between the two rations. Conversely, in the suckler bull study, intake was similar between the two rations but carcass weight was higher for the maize meal-based ration. Maize meal inclusion in the diet did not enhance carcass fat deposition in either study. Additionally, flaked-toasted maize was evaluated in the suckler bull study; animal intake, growth and carcass traits did not differ from the barley-based control ration.

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. The concentrates assessed were: a barley-soya 'control' ration (862 g/kg rolled barley, 60 g/kg soya bean meal, 50 g/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 800 g fresh weight maize dried distillers or wheat dried distillers grains/kg. Steers were individually offered 3 kg DM of the respective concentrates as a supplement to moderate DMD 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 3 kg 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 levels. 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; 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 dried distillers grains in the concentrate was about 800 g/kg when the concentrate ration was offered as a supplement to grass silage and about 200 g/kg when the ration was offered *ad libitum*. Thus, 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. These latter findings imply that the relative economic value of by-product feed ingredients is contingent on the feeding system.

## **Protein supplementation**

Weanling and finishing, steers and heifers, generally do not require protein supplementation when fed barley-based concentrates and high DMD grass silage, but for suckler bull weanlings, recent research at Grange showed a small response to protein supplementation. However, all cattle are likely to respond to supplementary protein in barley-based concentrates when grass silage has moderate to low DMD and/or low protein content, especially weanling heifers and steers, and young bulls.

## **Concentrate feeding: grazing**

Carcass growth response to concentrate supplementation at pasture is higher where grass supply is low and where grass quality is poorer and, usually declines as concentrate supplementation level increases. Studies at Grange have shown that at adequate (~20 g DM/kg live weight) grass allowances in autumn, feeding ~0.50-0.75 kg of concentrate per 100 kg live weight resulted in carcass growth responses in steers between 30 and 110 g carcass per kg concentrate. In practice, feeding this moderate level of concentrates will likely result in carcass growth responses at the upper end of this range.

For grazed grass, dietary energy rather than protein is the limiting factor and supplementation with concentrate energy sources is required. Three studies at Grange showed that cattle performance was similar for starch-based (barley) or fibre-based (pulp) concentrates as supplements to autumn grass.

## **Acknowledgements**

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## Feed efficient beef cattle

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### Summary

- Feed provision accounts for about 75% of variable costs in beef production; therefore, feed efficient cattle are fundamental to profitable beef farming.
- Depending on the beef production system operated, feed (cost) efficiency can be exploited via factors such as breed type selection, producing bulls compared to steers (or heifers), availing of compensatory growth and avoiding excessively long finishing periods.
- There is large variation in feed efficiency within breed types. Recent Teagasc research has shown differences in dry matter intake of over 20% within populations of cattle for the same performance.
- Current Teagasc research is evaluating the repeatability of feed efficiency in beef cattle and across different diets, and the genomic control of feed efficiency.

### Introduction

In beef production systems feed provision accounts for approximately 75% of total variable costs; therefore, small improvements in feed efficiency (FE) can have a relatively large influence on farm profitability. Additionally, feed efficient cattle excrete fewer nutrients to the environment. Consequently, there is considerable worldwide interest in FE as a means of improving the economic and environmental sustainability of beef production systems. Despite this, the rate of genetic improvement in FE of beef cattle has been slow relative to monogastric species such as pigs and poultry.

### Measures of feed efficiency

There are many different contexts, approaches and measurements of FE in beef cattle production ranging from the individual animal to the production system operated. In the context of the animal, traditionally, feed conversion ratio (FCR) (i.e. feed:gain) or its mathematical inverse, feed conversion efficiency (FCE) (i.e. gain:feed), was the measurement of choice. However, the use of this ratio in cattle breeding programmes generally leads to selection of faster growing animals that have a larger mature size and thus, a higher feed requirement. This has negative ramifications for the cow component of suckler beef production systems in particular because of the proportionately higher (overhead) costs associated with it. In essence, if an increase in feed requirements of the breeding cow herd offsets gains in growth efficiency, there will be no change in production system efficiency. Thus, there has been much interest, worldwide, in examining alternative FE traits such as residual feed intake, (RFI) (see later).

### Factors affecting feed efficiency

#### *Live weight*

In finishing beef cattle, up to two-thirds of feed consumed is used for body maintenance. As maintenance is largely a function of weight, a heavier animal requires more feed to maintain itself, and furthermore, for a fixed rate of live weight gain, the feed energy required is higher

for heavier animals. Consequently, FE is better with lighter, fast growing animals. For example, the daily energy requirements of a 650kg bull gaining 1.4 kg live weight per day is about 15% more than that of a 550kg bull gaining 1.4 kg live weight per day.

### *Duration of finishing period*

Live weight gain over the finishing period is not constant and generally is higher at the beginning and declines with increasing duration of finishing period. As slaughter weight increases, the proportions of non-carcass parts (hind-quarter, bone, total muscle and higher value muscle) decrease, while the proportions of carcass and carcass fats, fore-quarter and marbling fat all increase. As fat deposition requires more energy than protein deposition, more feed is required to produce a kilogram of fat. The practical implications of this are that FE deteriorates, and the feed cost per kg live weight and carcass gain increases, with increasing length of finishing period. For example, Teagasc research has shown that in steers offered a high-concentrate diet over 160 days, FE (kg DM intake/kg carcass) was 37% better during the first 80 days compared to the final 80 days of the finishing period. Therefore, avoiding overly-long finishing periods and ensuring that animals achieve minimum carcass fat score without impairing carcass value are ways to reduce feed requirements and costs.

### *Compensatory growth*

This is the ability of an animal to undergo accelerated growth when offered unrestricted access to high quality feed after a period of restricted feeding or under-nutrition. This phenomenon can be readily exploited by producers through 'storing' (target growth rate, 0.5-0.7 kg live weight daily) weanling cattle during the expensive indoor winter period and subsequently availing of compensatory (or 'catch-up') growth when offered lower-cost grass during the following grazing season. Compensatory growth may also be exhibited during the indoor finishing phase by cattle that experienced sub-optimal growth earlier.

### *Gender*

Bulls are inherently more feed efficient than steers, who in turn, are generally more efficient than heifers. Research in Ireland and elsewhere comparing steers and bulls of similar breed, reared under similar management on the same diet and slaughtered at the same age, showed that growth and FE traits were 10 to 20% better for bulls than steers. Differences in favour of bulls were generally more pronounced at higher feeding/feed energy levels and with increasing slaughter weight. The enhanced performance of bulls over steers is due to naturally occurring male steroid hormones.

### *Breed type*

In general, beef breeds and beef crossbreds are more feed efficient than beef x dairy breeds, who in turn, are more efficient than Friesian and Holstein. For example, a study at Grange showed that suckler-bred beef cattle gained about 23% more live-weight during the finishing period per unit of energy consumed than Holstein/Friesian breeds when slaughtered as either bulls at 15 months of age or as steers at 24 months of age. However, because of the higher kill-out proportion and the greater proportion of meat in the carcass of beef compared to dairy breeds the percentage of meat produced per unit of energy consumed was, on average, 51% greater for the beef than the dairy breed. Within the beef breeds, late-maturing breeds are more feed efficient than early-maturing breeds, especially in terms of carcass weight and muscle production. It is important to bear in mind that comparison of intake and efficiency data for cattle breed types must be interpreted in the context of the production system operated and slaughter end point of the comparisons, as the ranking could vary with changes in these factors.



## Variation in feed efficiency within cattle populations

The concept of residual feed intake (RFI), rather than feed conversion ratio, is becoming the preferred measure of FE across many livestock production enterprises, and in particular for beef cattle. Cattle with low RFI (efficient) consume less feed than expected based on their live weight and growth. The advantage of using RFI as a means of selecting for improved FE is that it is independent of growth and carcass traits in growing beef cattle. This has positive implications for maintenance requirements of both growing and mature cattle. Research studies at Teagasc, Grange and elsewhere have also demonstrated significant genetic variance in the trait and that, genetically, it is not antagonistically associated with desirable growth or carcass traits in growing beef cattle. Indeed, Teagasc research has shown that in any group of growing cattle or suckler cows there can be up to 20% difference and greater in the feed consumed by the most efficient compared to the least efficient animals for the same level of growth and performance (Table 1). The challenge is, therefore, to reliably and cost-effectively identify these feed efficient animals and proliferate their genetics through structured animal breeding programmes.

**Table 1.** Intake and performance of beef cattle within the bottom one third (efficient) and top one third (inefficient) of the population ranked on residual feed intake (RFI)

	RFI		Sig. <sup>1</sup>	Difference in dry matter intake (%)
	Low (efficient)	High (inefficient)		
<i>Finishing bulls</i>				
Dry matter intake (kg/d)	9.0	10.2	***	13
Live weight (kg)	509	516	NS <sup>2</sup>	
Average daily gain (kg)	1.55	1.66	NS	
<i>Growing heifers</i>				
Dry matter intake (kg/d)	5.5	6.3	***	15
Live weight (kg)	330	316	NS	
Average daily gain (kg)	0.60	0.60	NS	
<i>Pregnant beef cows</i>				
Dry matter intake (kg/d)	7.6	9.5	***	25
Live weight (kg)	679	676	NS	
Average daily gain (kg)	0.56	0.68	NS	

<sup>1</sup>Denotes a statistically significant difference between feed efficiency groups

<sup>2</sup>NS = Not statistically significant

## Biological processes affecting feed efficiency

Our own work at Teagasc to-date has also clearly shown that FE is a complex multifaceted trait, under the control of many biological processes. These include inter-animal variation in feeding behaviour, digestion, absorption, metabolism, nutrient partitioning, and cellular energetics, as well as, potentially, susceptibility to stress. For example, we have shown that feed efficient cattle (low RFI) have fewer eating bouts and shorter total feeding duration compared to their inefficient counterparts. Our data has demonstrated that feed efficient

heifers consumed 15% less feed and produced 14% less methane than their inefficient contemporaries for the same weight and growth. In a separate study, the composition of the ruminal microbial (or 'bugs') population in low RFI and high RFI heifers offered successive contrasting diets (forage-based then concentrate-based diet) was examined in order to characterise the diversity of the methanogenic (methane-producing) microbes in heifers differing in FE. We found that the abundance of the methanogenic microbes did not differ between animals divergent for FE, but their prevalence was affected by diet type, in that more methanogenic microbes were present when both groups of heifers were consuming the concentrate-based diet. Consequently, the aforementioned difference in methane production is likely to be mainly intake-related rather than linked to the population of micro-organisms residing in the rumens of efficient cattle. More recent Teagasc research found that in cattle offered a high concentrate diet more feed efficient animals harboured a greater abundance of cellulolytic bacteria compared to their inefficient counterparts. The presence of more cellulolytic bacteria may possibly result in enhanced digestion of cellulose in feed efficient animals and an improvement in their utilisation of nutrients.

## Current research on feed efficiency in beef cattle

Worldwide, breeding values of bulls for feed intake or FE are typically derived from progeny performance based on *ad libitum* access to energy dense rations whereas, in many countries including Ireland, the lifetime gain of most commercial beef cattle is achieved from diets consisting, to a significant extent, of lower energy dense feeds such as grazed grass and/or ensiled forages. There is evidence from our own work, and that of others, that although relatively repeatable, ranking of beef cattle for FE offered the same diet is not necessarily consistent over different phases of their lifetime, and this may be further exacerbated when diets differing in energy density are fed successively (i.e. forage versus concentrate based diets), as per commercial practice. This strongly indicates the presence of what is termed a 'genotype x environment' interaction for the trait, in other words that the relative FE of a particular animal depends on the type of feed it is offered or management system within which it is reared. However, the existence of such a phenomenon has not been adequately tested to-date.

On-going research by our group, funded by the Department of Agriculture, Food and the Marine, is examining the existence of genotype x age and genotype x environment (diet) interactions for FE. This project used 100 Charolais and 100 Holstein-Friesian cattle offered a series of contrasting diet types *ad libitum* in the following sequence: High concentrate diet + 10% roughage (DM basis); high nutritive value grass silage plus minerals & vitamins; zero-grazed grass only; grazed grass only (i.e. grazing period) and finally, a high concentrate diet + 10% roughage (DM basis). Each of the dietary feeding periods comprised of a minimum of 70 days preceded by an adaptation period of about 21 days. Detailed supporting animal measurements were taken. The project also aims to identify easy to collect biological markers and also the key genes controlling the trait so that such information can ultimately be incorporated into the planned genomic selection based breeding programme for beef cattle in Ireland. This should, in time, aid the identification of animals that are most profitable to produce under our grass-based production systems.

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## Male suckler cattle production

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### Summary

- Late-maturing breeds predominate in Irish suckler beef production systems.
- Growth rates in weanlings will respond to winter concentrate supplementation, but subsequent compensatory growth at pasture offsets the economic advantage of higher supplementation levels.
- Concentrate supplementation of yearling cattle at pasture in spring generally improves animal performance, but is often insufficient to meet the input cost of the concentrates.
- In well-managed summer/autumn pastures the animal live weight response to concentrate supplementation is often only breakeven in economic terms.
- To achieve the same carcass weight as late-maturing breed bulls, early-maturing breed animals needed to be heavier at slaughter due to a lower kill-out proportion and, had a higher carcass fat score and a longer duration to slaughter than late-maturing breed types.

### Introduction

Irish beef production is largely pasture-based where, collectively, grazed and conserved pasture account for almost 90% of the lifetime feed consumption. To coincide with the onset of the grazing season, the national suckler herd is predominantly spring-calving. In an integrated spring-calving suckler calf-to-beef research production system, progeny spend the first 6 to 8 months at pasture, are then weaned and housed for the winter for a 'store' period. During this store period, they are generally offered grass silage *ad libitum* and, depending on the silage nutritive value, 1-3 kg concentrates/head/day. Yearlings return to pasture for a second grazing season and, in the case of steers, are housed in the late autumn for finishing at about 24 months of age on a diet comprising about 50:50 grass silage:concentrate mixture on a dry matter (DM) basis. Nationally, however, mean slaughter age of steers is 28-29 months, which means many cattle spend some or most of a third grazing season at pasture. As levels of animal growth in one period of the production cycle can have an influence on live weight gain at a later stage, optimisation of animal performance at the various stages of the cycle is a challenge for producers. In practice, many weanlings leave their farm of birth during their first year of life and subsequently, may move again to other farms before final finishing. Steer production predominates in Ireland but more recently about 25% of male progeny are finished as bulls. Suckler herd progeny account for approximately 45% of the national male kill and late-maturing breeds and their crossbreds predominate.

The focus of this paper is on post-weaning performance of suckler bred male cattle. Firstly, it examines recent results from Teagasc Grange on the effects of weanling bull winter growth rate on subsequent performance at pasture and during finishing, secondly, it examines the role and response to concentrate supplementation at pasture in spring and autumn and how this influences animal performance and, thirdly, it compares the growth and carcass traits of early- and late-maturing breed bulls reared on contrasting production systems.

## Weanling cattle performance

Research studies at Grange have determined that the optimum winter growth rate for steers destined to return to pasture for a second grazing season is in the region of 0.5 kg live weight gain/day, if they are to subsequently optimise compensatory growth on cheaper produced grass. In other words, there is little point in over-feeding weanlings in winter as, during the subsequent grazing season, cattle that gained less over the winter have the highest live weight gain at pasture. This ability of animals 'restricted during the winter' to subsequently compensate at pasture means that the majority of the winter weight difference, due to higher levels of supplementation, disappears by the end of the grazing season. However, unlike steers, the optimal first-winter growth rate for young suckler bulls to exploit subsequent compensatory growth at pasture is not clear.

Recent research at Teagasc Grange has addressed this issue and is summarised in Table 1. At the end of a 120 day first winter suckler bulls offered grass silage to appetite and supplemented with either 4 or 6 kg concentrates daily were 26 and 65 kg heavier, respectively, than those supplemented with 2 kg concentrates. At pasture, average daily live weight gain was greatest for animals that received the lowest amount of concentrates during the previous winter. By housing time (in July), there was no difference in live weight between the 2 and 4 kg winter supplemented groups, however, the 6 kg winter supplemented group were still 32 kg heavier. Thus, the additional 32 kg live weight gain for the 6 kg concentrates supplementation level (relative to 2 kg of concentrates) resulted in a ~15:1 response. At slaughter, there were no significant differences between the three winter supplementation levels for carcass weight, kill-out proportion, or carcass fat score. Carcass conformation score was not improved by the increased first winter concentrate feeding levels.

**Table 1.** Effect of growth rates during the first winter on live weight gains, carcass weight, kill-out proportions and, fat and conformation scores in young bulls.

	Winter supplementation level (kg concentrate/head/day)			Sig.
	2	4	6	
Live weight gain (kg/day)				
Indoor winter period	0.79	1.01	1.27	*
Pasture	1.20	0.95	1.03	**
Carcass weight (kg)	389	382	378	NS
Kill-out proportion (g/kg)	556	552	553	NS
Carcass conformation score (1-15)	9.8	9.4	9.0	*
Carcass fat score (1-15)	6.8	6.5	6.2	NS

In a consequent similar study, where suckler bulls were offered 3 or 6 kg concentrates as a supplement to grass silage over a 127 day indoor winter period and subsequently returned to pasture, it was found that bulls fed 6 kg concentrates during their first winter were 30 kg heavier at slaughter (13:1 response), resulting in a 20 kg heavier carcass, than animals which received 3 kg concentrates for the first winter.

## Steers and bulls compared

Upon reaching puberty, bulls are inherently more efficient than steers, due to naturally-occurring male steroid hormones. In a recent study at Grange, weaned, spring-born, late-maturing breed suckler bulls and steers (about eight months old, 360 kg) were compared in

each of two contrasting production systems; forage (grass)-based or concentrate-based. At the end of a 'store' winter period, during which all animals were fed grass silage to appetite plus supplementary concentrates, half of the bulls and steers were offered a high concentrate diet, whereas the remainder were turned out to pasture for 98 days (growing phase), following which, they were then rehoused and offered the high concentrate diet. Mean slaughter age for all animals was 19 months. Apart from live weight at the end of the first winter, where bulls and steers were of similar weights, and, fatness at slaughter, where steers were fatter, bulls had significantly greater growth rate, carcass weight and conformation score (Table 2). For the grass-based system, daily live-weight gain of bulls was approximately 0.2 kg greater than steers whilst grazing, with this advantage increasing further when subsequently finishing indoors. On the 15-point carcass classification scale, bulls were one score leaner and one score better in conformation, than steers.

**Table 2.** Effect of gender (Gen.) and diet (Diet) on growth and carcass traits of suckler bulls and steers.

Gender Diet	Bulls		Steers		Significance	
	Grazed	Conc.	Grazed	Conc.	Gen.	Diet
Live weight: end of winter (kg)	438	464	433	468	NS	***
Live weight gain: growing (kg/day)	1.49	1.82	1.28	1.64	**	***
Live weight gain: finishing (kg/day)	1.79	1.33	1.51	0.87	***	***
Slaughter weight (kg)	711	728	651	683	***	NS
Kill-out proportion (g/kg)	571	575	559	560	**	NS
Carcass weight (kg)	406	419	364	382	***	NS
Carcass fat (1-15)	6.7	7.9	7.9	8.6	*	**
Carcass conformation (1-15)	9.9	10.2	8.9	9.1	**	NS

## Concentrate supplementation at pasture: spring/summer

A study was undertaken to examine the effects of concentrate supplementation level at pasture in spring/summer on performance of suckler-bred weanling bulls. They were offered either zero, 2.7 kg or 5.3 kg concentrates/head daily for 100 days. At the end of the grazing period bulls were housed and finished on an *ad libitum* barley-based concentrate diet and slaughtered at an average age of approximately 19 months. After 100 days at pasture, the zero concentrate supplemented animals were 17 kg and 36 kg lighter than those getting 2.7 kg and 5.3 kg concentrate/day, respectively. During the finishing phase, highest growth rates occurred in the animals that were unsupplemented at pasture. At slaughter, the low and high pasture supplementation levels were 7 kg and 24 kg live weight heavier than the unsupplemented group. The respective additional carcass weight produced for 2.7 v 0 kg, 5.3 v 0 kg and 5.3 v 2.7 kg (fed at pasture) were 6 kg, 20 kg and 14 kg. Overall, it was concluded that concentrate supplementation at pasture increased animal live weight, however, the scale of the differences were such that the economics of concentrate supplementation were marginal.

In another study, spring-born suckled bulls spent 200 days at pasture where for the first 100 days they received either grass only or grass supplemented with concentrates which approximated to 50% of their daily DM intake. Supplemented animals grew at 1.69 kg live weight per day over the first 100 days compared with 1.44 kg/day for the unsupplemented group, and were, 25 kg heavier after 100 days (a live weight response of ~22:1). After 100



days at pasture, half of the unsupplemented animals were then offered pasture only or a concentrate supplement at pasture, which approximated to 50% of their daily DM intake. From day 100 to 200, the unsupplemented bulls had a daily live weight gain of 0.92 kg at pasture, while the supplemented group had a daily gain of 1.24 kg. When slaughtered, bulls supplemented for the final 100 days at pasture had a carcass weight that was 10 kg heavier than the grass-only bulls. This additional carcass weight came from both a higher slaughter weight (+20 kg live weight) and kill-out proportion (6 g/kg). Bulls that were supplemented throughout the grazing season (200 days of supplementation) had a carcass weight that was 9 kg heavier than those that were supplemented only for the final 100 days. The additional carcass weight was due to a better kill-out proportion (19 g/kg). It was concluded that the economics of pasture concentrate supplementation (for the conditions prevailing in this study) were, at best, marginal.

## Late-and early-maturing breed bulls

A challenge for late-maturing breeds (e.g., Charolais, Limousin) can be to achieve adequate carcass fat cover at a young slaughter age. In this context, early-maturing breeds (e.g., Aberdeen Angus, Herefords) may be more suitable. A study was undertaken to determine growth and carcass characteristics of spring-born early- and late-maturing breed suckler bulls slaughtered at four carcass weights (Table 3 shows the average of the four carcass weights). Bulls were finished indoors on a high-concentrate diet and were slaughtered on reaching the appropriate live weight to achieve the target carcass weight. To achieve the same carcass weight as late-maturing breed bulls, early-maturing breed animals needed to be heavier at slaughter due to a lower kill-out proportion and, had a higher carcass fat score, a longer duration to slaughter and were older at slaughter, compared to late-maturing breed types. Concentrate DM intake and daily live weight gain did not differ significantly between the breed types. However, early-maturing breed bulls needed 50 days extra feeding to reach a common carcass weight. Therefore, when slaughtered at a common carcass weight the data indicate that early-maturing breed animals were less efficient.

**Table 3.** Intake, growth, and carcass attributes of early- and late-maturing breed suckler bulls

	Breed type		Sig
	Early-maturing	Late-maturing	
Live weight at start (kg)	303	345	***
Slaughter weight (kg)	591	569	*
Kill-out proportion (g/kg)	548	572	***
Carcass weight (kg)	324	326	NS
Carcass fat score (1-15)	8.6	7.0	***
Carcass conformation score (1-15)	8.2	8.9	*
Days on farm	215	165	–
Concentrate intake (kg DM/day)	9.6	9.7	NS
Average daily live weight gain (kg)	1.5	1.5	NS

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## Can the producer influence beef quality for the consumer?

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### Summary

- Increasingly farmers must produce beef to specific market specifications.
- The diet of cattle can affect the colour of fat but has little effect on the colour of lean meat. Among breeds, Jersey-sired cattle have more yellow carcass fat than other breeds.
- Post-farm management has a greater effect on tenderness than on-farm management.
- When slaughtered at a similar fatness, there is little difference between breeds in tenderness or overall consumer acceptability of meat.
- The diet of cattle can influence the amount of healthy compounds in beef.
- Based on current evidence, increasing age at slaughter (up to 22 months at least) does not negatively influence the tenderness of suckler or dairy bull beef but the type of production system may have a small effect.
- Considerable opportunity exists among on-farm production options to meet market specifications.

### Introduction

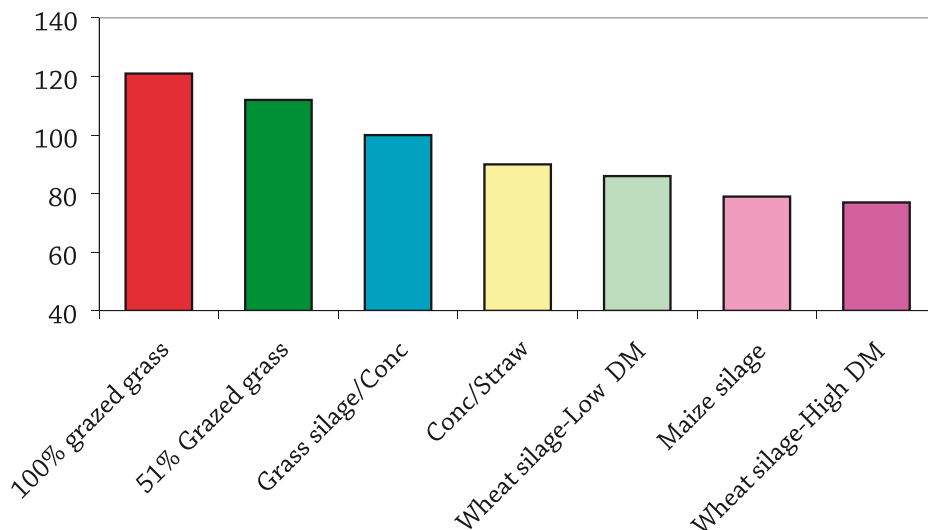
Purchasers of beef at all points in the production chain (e.g. factory or retail buyers, processors, restaurateurs, individual shoppers, etc.) can each be considered as beef consumers. As more than 85% of Irish beef is exported there are a myriad of markets and consumers for Irish beef. Each consumer may therefore have a different definition of beef quality. The challenge for beef farmers is to know the preferences/requirements of their target consumer and to most cost-effectively meet these requirements. Within the broad definition of beef quality, the appearance, shelf-life and eating quality can be affected by management of the animal on-farm, during transport and slaughter, management of its carcass during the early post-slaughter period and management of its meat during maturation and cooking. An objective of the Teagasc meat quality research programme is to provide beef farmers with the information to allow them to produce beef that is suitable for specific markets. It is important to note that the effects of the diet of cattle on beef quality may be direct i.e. other carcass traits have not changed, or they may be indirect i.e. factors such as carcass weight, age or fatness may change as a result of a change in diet and these may then influence beef quality.

### Colour of beef

#### Fat

Consumers in some EU markets, particularly in Mediterranean countries, require carcasses that have white fat. The diet of beef cattle can change fat colour. The yellowing effect on fat of different feeds can be ranked in decreasing order as follows: grazed grass, grass silage/

concentrates, concentrates/straw, whole-crop maize silage and finally whole-crop wheat silage, as shown in Figure 1. The colour of fat from cattle fed a barley grain-based ration was similar to that of cattle fed maize grain or fodder beet-based rations. Carcass fat from Jersey-sired cattle was more yellow than that from other breeds.



**Figure 1.** The yellowing effect of different feeds on carcass fat (grass silage + concentrates = 100; higher values are more yellow).

## Meat

The appearance and/or colour strongly influence the decision to purchase an individual cut of meat. Consumers generally choose bright red rather than darker meat. In our studies we see little effect of concentrate-based rations, concentrate type or grazed grass *per se* on lean meat colour. There are however, reports of darker meat being produced from grazed cattle compared to ‘feedlot’ cattle in the United States but these studies are usually confounded by differences in animal age at slaughter and the management of the grazing animals is more extensive than that practised in Ireland. Animal age appears to be a more important determinant of meat colour than diet with younger cattle having meat that is lighter and less red in colour. Minimising pre-slaughter stress is important, particularly for bulls, to ensure that meat does not become dark due to the higher than normal pH that develops in the muscle of stressed animals. The shelf-life or colour stability of beef can be affected by the diet consumed by cattle. In general, grass-fed beef has a longer shelf-life than concentrate-fed beef, mainly due the greater amount of anti-oxidants present in the meat. Increasing the susceptibility of the fat in beef to oxidation can decrease its colour stability and therefore, a high-fat diet offered to cattle may need to be supplemented with an anti-oxidant such as vitamin E.

## Nutritional quality of beef

Beef is generally recognised as a good source of protein, minerals and anti-oxidants but there is also a perception that beef is rich in “unhealthy” saturated fatty acids. However, lean beef with less than 4% fat can be considered a low-fat food. The emphasis on decreasing the

consumption of saturated fatty acids is being increasingly questioned, but medical authorities currently advise a decrease in their consumption and an increase in the consumption of monounsaturated and polyunsaturated fatty acids (PUFA). Within the PUFA, increasing the intake of omega-3 fatty acids is particularly encouraged. Conjugated linoleic acid (CLA) is a fatty acid in beef that may protect against cancer and other diseases. Cattle nutrition is the major factor influencing meat fatty acid composition. An increase in energy consumption by cattle can increase the fat concentration in beef (intramuscular fat or marbling), and this in turn can influence the fatty acid composition independent of the nature of the diet offered. Feeding grass and/or feeding concentrates containing linseed, fish oil or algae, compared to a standard concentrate ration, results in beneficial changes in the omega-3 PUFA and CLA in beef. These benefits can be enhanced further by preventing dietary PUFA from being digested (hydrogenation) in the rumen by feeding 'protected' forms of supplement. When rumen-protected PUFA were fed to cattle, the concentration of beneficial omega-3 PUFA increased to an extent that the meat complied with the European Food Safety Authority definition of a "source" of omega-3 PUFA. However, this beef had a shorter shelf-life, indicating that additional dietary anti-oxidants were required in the supplement fed to the cattle. There is considerable interest in the possible health benefits of grass-fed beef. While the levels of omega-3 PUFA in grass-fed beef are below the definition of a 'source', grass-fed beef can contribute to overall omega-3 PUFA consumption. Research on the potential human health benefits of grass-fed beef is underway in a collaborative project between Teagasc and University College Dublin - supported through the Department of Agriculture, Food and the Marine Competitive Research Programmes (13/F/514). The challenge for the food industry is to develop strategies to market grass-fed beef as a meat that is more in line with human health requirements than alternative sources.

## Eating quality of beef

Tenderness is considered to have a major influence on the enjoyment that comes from eating beef. Overall acceptability is an assessment of satisfaction which also incorporates flavour and juiciness. Post-slaughter management of the carcass, such as rate of cooling, electrical stimulation and, in particular, ageing/hanging can have a big influence on tenderness and overall acceptability. Equally, how the beef is cooked can influence its overall acceptability. Thus, the treatment of the meat from carcass to plate can mask the effects of the diet of the animal on the farm.

In general, if slaughtered at the same carcass weight/fatness, the composition of the diet does not greatly influence beef tenderness or overall acceptability. For example, in a recent study at Teagasc, Grange, early-maturing breed heifers were fed concentrates *ad libitum* or un-supplemented grass silage followed by grazed grass from weaning until slaughter at a similar carcass weight (260 kg) and there was no difference in tenderness and overall acceptability of the meat.

An increase in energy consumption by cattle will increase growth and carcass fatness. If slaughtered at the same age, carcasses from cattle fed the higher energy ration will likely be fatter and since fat has a small positive influence on tenderness, an apparent positive effect may be seen. Generally, growth rate before slaughter does not greatly influence beef tenderness; however, there is some evidence that rapid growth following a period of restricted growth decreases tenderness compared to meat from cattle that grow at a more even rate throughout the finishing period.

When slaughtered at a constant carcass fatness there is little difference between breeds in tenderness. For example, striploin from Belgian Blue x dairy heifers, slaughtered at a carcass

weight of 327 kg, had similar intramuscular fatness and overall acceptability to striploin from Angus x dairy heifers slaughtered at a carcass weight of 237 kg (Table 1). In this study there was an improvement in overall acceptability of the striploin as the animals became older.

**Table 1.** Carcass and meat characteristics of Angus x dairy and Belgian Blue x dairy heifers slaughtered at two live weights

	Angus-cross		Belgian Blue-cross		Significance	
	Light	Heavy	Light	Heavy	Breed	Age
Carcass (kg)	237	305	256	327	**	**
Fat score (1-5)	3.44	4.20	2.49	3.73	*	**
Intramuscular fat (g/kg) <sup>1</sup>	49	67	38	41	*	*
Tenderness <sup>2</sup>	4.31	4.65	4.48	4.76	NS	*
Juiciness <sup>2</sup>	5.06	5.48	5.24	5.27	NS	*
Beef flavour <sup>2</sup>	4.46	4.58	4.26	4.46	*	*
Abnormal <sup>2</sup>	1.93	1.94	2.06	2.29	**	**
Overall acceptability <sup>3</sup>	46.6	52.7	41.5	46.6	*	*

<sup>1</sup> Note: significant interaction between breed and age.

<sup>2</sup> Categorical scale: 1 (least) – 4 (most); <sup>3</sup> Line scale: 0 (least) – 100 (most)

The age at which an animal, particularly a bull, is slaughtered is of current interest specifically with regard to beef tenderness and overall acceptability. Recent Teagasc studies indicate that there is little commercially important difference in tenderness or overall liking of striploins from late-maturing continental breed sired suckler bulls slaughtered between 15 and 24 months of age or from dairy bulls slaughtered at 16, 19 or 21 months of age. There was some evidence that production system *per se* may have a small negative effect on eating quality. For example, when suckler bulls from early- or late-maturing breed sires were slaughtered at 380 kg carcass from an *ad libitum* concentrate diet or grazed prior to finishing on an *ad libitum* concentrate diet, the tenderness rating by trained assessors was lower for the grass-based system. The scale of this decrease is unlikely to be detected by untrained consumers. There was little difference between early- and late-maturing breed types. This topic is still under investigation, as is a comparison of bulls and steers from the beef suckler herd and the dairy herd within a project supported through the Department of Agriculture, Food and the Marine Competitive Research Programmes (11/SF/322).

## Conclusions

The expectations of the customer/consumer at each point in the supply chain must be satisfied. This requires clear market signals on the requirements and/or preferences of each consumer group in the production chain. To sustain the beef industry, beef farmers must also be adequately rewarded for meeting market specifications, especially if it is more expensive, or more challenging, to produce novel or “enhanced” beef. Information is now available to assist farmers to more consistently meet consumer requirements.

## Acknowledgements

The information summarised here has been generated within projects supported by Teagasc, EU Framework programmes and the Department of Agriculture, Food and the Marine. The support of Kepak Group and Dawn Meats in the suckler and dairy bull studies, respectively, mentioned above is acknowledged.





# **Technology Village:**

## **Improving Animal Health**

## Passive immunity and health of suckler beef and dairy calves

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### Summary

- In a large-scale observational study on Irish farms, more than 20% of suckler beef calves and 14% of dairy calves were found have inadequate passive immunity.
- Calves with inadequate passive immunity are at greater risk of disease.
- Colostrum quality varies between individual cows.
- Calves should consume first-milking colostrum within 1 to 2 hours after birth.
- Farmers should consider implementing a testing programme to monitor the passive immune status of their calves.

### Introduction

The bovine placenta prevents the *in utero* transfer of immunoglobulins (Ig) from dam to calf. Consequently, calves are immunologically naïve at birth and dependent on passive immunity for protection against disease challenges in early life. Passive immunity is achieved through ingestion and absorption of colostrum ('first milk') Ig immediately after birth. The calf's small intestine has the ability to absorb Ig during the first 24 hours of life, but the efficiency of absorption begins to decline within a few hours of birth. Failure of passive transfer (FPT) of immunity occurs when the calf does not absorb sufficient Ig within this time period. It is well established that calves with FPT are at greater risk of morbidity and mortality, begin exhibiting clinical signs of disease at younger ages, and experience an increased number of sick days and reduced growth performance when compared to calves with adequate passive immunity.

### Achieving adequate passive immunity in suckler beef calves

Recommended colostrum management practices often focus on the dairy calf. Dairy farmers are routinely advised to adopt the 1-2-3 approach to colostrum feeding: 1) use first-milking colostrum for the first feed, 2) ensure the calf ingests colostrum within 2 hours after birth, and 3) have the calf consume at least 3 litres of colostrum during the first feeding. Implementing the 1-2-3 approach with suckler beef calves would not be practical. Hence, colostrum management programmes on suckler beef farms need to emphasize the importance of colostrum quality and the timing of colostrum ingestion, and how these factors can be manipulated and monitored by the farmer.

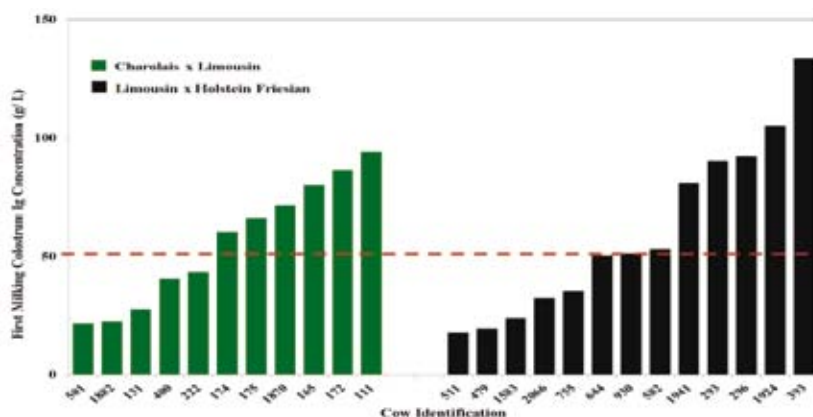
#### 1) Colostrum quality

Ensuring the suckler calf consumes sufficient quantities of good quality colostrum immediately after birth is the first step in achieving adequate passive immunity. Colostrum 'quality' is a term used to describe the Ig concentration in colostrum. First-milking colostrum contains high levels of Ig (twice as high as second-milking colostrum), along with other immune factors and nutrients. Good quality colostrum is classified as containing a minimum

of 50 g/l of immunoglobulin G (IgG). IgG is the main type of Ig present in colostrum. There are instruments that farmers can use to assess the quality of colostrum consumed by their calves. The colostrometer (also known as the hydrometer) estimates colostrum IgG content by measuring the specific gravity of colostrum; however, this instrument is fragile and colostrum must be tested at room temperature in order to obtain a reliable result. The BRIX refractometer uses total solids percentage to estimate colostrum quality. North American research has demonstrated that this instrument is less sensitive to variation in temperature and that a BRIX value of > 21% can be used to identify colostrum with IgG > 50 g/L. These tools could be useful for on-farm use, especially if a farmer was planning to collect and store colostrum in a freezer for later use.

First-milking colostrum samples were collected from 79 cows on seven Irish commercial suckler herds between January and May 2016, and it was determined that approximately one-third of these cows had low quality colostrum (defined in this case as  $\leq 21\%$  BRIX). Farmers need to appreciate that there can be tremendous variation in colostrum quality between individual cows. Figure 1 demonstrates how widely colostrum IgG concentrations for suckler beef cows within a single herd can vary.

The main factors that impact colostrum quality are breed, parity and pre-calving nutrition of the dam. Compared to dairy cows, suckler beef cows produce smaller volumes of colostrum with greater IgG concentrations. This is especially noteworthy for farmers that obtain colostrum from dairy farms to feed to their suckler beef calves. This practice should be discouraged because not only is there the biosecurity risk of introducing pathogens to the suckler beef herd, but the suckler calf is also likely to be receiving relatively low quality colostrum. Research at Teagasc Grange has shown that beef  $\times$  dairy cows have a higher colostrum yield and Ig mass, and subsequently their calves have superior passive immune status, compared to beef breeds. Another consideration is that heifers will generally have lower colostrum yield and Ig mass than older cows. Furthermore, it should be noted that cows with a low body condition score (BCS) or those maintained on a pre-calving diet that leads to severe nutrient restriction could potentially be at risk of producing lower colostrum Ig mass.



**Figure 1.** IgG concentrations for first-milking colostrum samples collected from multiparous suckler beef cows in a research herd. Good 'quality' colostrum was defined as containing a minimum of 50 g/l of Ig.

## 2) Timing of colostrum ingestion

Timing of colostrum ingestion can influence the acquisition of passive immunity. Although, the small intestine is open to colostrum Ig transfer for the first 24 hours of life, the efficiency of absorption progressively declines with time. The efficiency of Ig absorption is greatest in the

first few hours after birth, decreases to approximately 50% by 6 hours, and stops by 24 hours. Therefore, in an effort to reduce the likelihood of calves experiencing FPT, farmers should aim to have every calf consume first-milking colostrum by either suckling or hand-feeding within 1 to 2 hours after birth. In addition, farmers should closely monitor situations where suckling is likely to be delayed (e.g. weak calf, difficult birth, twins, poor cow-calf bonding etc.). Research at Teagasc Grange has shown that feeding the calf 5% of its birth weight (e.g. ~2 l of colostrum for a 40 kg calf) within 1 hour of birth, with subsequent suckling of the dam 6 to 8 hours later, ensures adequate passive immunity.

## Assessing passive immunity in calves

Passive immunity can be assessed using blood serum samples collected from young calves. Farmers that would like to investigate implementing a testing programme to monitor whether their calves are receiving sufficient colostral protection against infectious disease should speak with their veterinarian. This exercise would be especially useful during disease outbreak situations or on farms where there has been an on-going history of calf health problems. Multiple tests are available to detect FPT in calves and to monitor the effectiveness of on-farm colostrum management programmes. Radial immunodiffusion (RID) and enzyme linked immunosorbent assay (ELISA) are testing procedures that directly measure blood serum IgG concentration. Indirect test methods, such as the zinc sulphate turbidity (ZST) test, can also be applied to estimate calf serum IgG levels. Indirect tests are usually less labour-intensive and relatively inexpensive compared to the direct testing methods. Farmers should seek advice from their veterinarian about sampling and testing procedures, and interpretation of test results.

## Passive immune status of Irish suckler beef and dairy calves

The All-Island Animal Disease Surveillance Programme (Department of Agriculture, Food and the Marine (DAFM) in the Republic of Ireland and Agri-Food and Biosciences Institute in Northern Ireland) reports that between 40 and 66% of calf serum samples submitted annually to veterinary laboratories have FPT (defined in this case as <20 ZST units). However, these samples are generally voluntary submissions from clinically ill calves or animals in herds with on-going calf health problems. Hence, these FPT estimates are unlikely to be reflective of the overall national herd status.

A large-scale observational study, funded by DAFM, was implemented to formally evaluate the passive immune status and health of Irish suckler beef and dairy calves. In year 1 of this study, a total of 111 suckler beef farms and 84 dairy farms throughout Ireland were visited during the autumn 2014 and spring 2015 calving seasons. Blood samples were collected from 923 suckler beef and 1,040 dairy calves between one- and 21-days of age, and serum was analysed using the ZST test. The ZST results were categorized as: Low = '<10', Medium = '10-20' or High = '>20' units (Table 1). Suckler beef calves were more likely to have ZST results in the lower categories than dairy calves. This is an unexpected result because dairy cows generally have lower colostrum quality than suckler beef cows.

A cut-point value of less than 20 ZST units, which includes the Low and Medium categories, is commonly used to describe FPT. With this interpretation, approximately 72% of suckler beef calves and 64% of dairy calves had FPT, which suggests that the aforementioned disease surveillance estimates have underestimated the prevalence of FPT in Irish calves. New reports, however, from the Limerick Regional Veterinary Laboratory (DAFM) have proposed that a lower ZST cut-point value for FPT needs to be adopted. Hence, if only the Low category results are interpreted as indicative of FPT, then approximately 21% of suckler beef calves and



14% of dairy calves had inadequate passive immunity. Research is on-going at Teagasc Grange to determine more appropriate FPT cut-off point values for ZST, as well as other indirect testing methods. Moreover, associations between FPT and herd management practices will be examined.

**Table 1.** Mean ( $\pm$  standard deviation) sampling age, ZST results and incidence of disease for calves blood sampled during the autumn 2014 and spring 2015 calving seasons

	<b>Suckler beef calves (n = 923)</b>	<b>Dairy calves (n = 1,040)</b>
<i>Sampling age (days)</i>	11.0 $\pm$ 5.6	9.6 $\pm$ 5.3
<i>ZST results</i>		
Low	21%	14%
Medium	51%	50%
High	28%	36%
<i>Incidence of disease from birth to 3 months of age*</i>		
Overall disease risk	25%	17%
Scours risk	7%	12%
Respiratory disease risk	7%	1%
Navel/joint infection risk	5%	1%

\* Disease data available for 577 suckler beef calves and 683 dairy calves

## Calfhood disease for Irish suckler beef and dairy calves

Participating farmers were requested to complete detailed health records for each calf blood sampled during year 1 of the study. Standardised case definitions for disease were provided. A disease event was defined as a calf being treated for at least one case of disease between birth and three months of age. Health records were obtained for 577 calves from 73 suckler beef farms and 683 calves from 54 dairy farms. In total, 25% of suckler beef calves and 17% of dairy calves were treated for at least one disease event in the first three months of life (Table 1). The overall risk of being treated for at least one disease event in suckler beef versus dairy calves was not significantly different. Suckler beef calves with Low ZST were significantly more likely to be treated for disease than suckler beef calves in the Medium or High ZST categories. The risk of dairy calves experiencing a disease event did not differ by ZST status. Research is on-going to identify risk factors for scours and respiratory disease, and to evaluate associations between herd-level management practices and herd health status.

## Conclusions

Implementing an appropriate colostrum management programme and achieving adequate passive immunity should be a priority on every farm. Many Irish calves are currently at risk of FPT. Calves with inadequate passive immunity are more likely to require treatment for calfhood disease. Research is on-going to identify the risk factors for FPT and disease, as well as to better understand the relationships between passive immunity, calf health, survival and management.

## Acknowledgements

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## Parasite control at grass

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### Summary

- Parasites have a significant impact on performance and health of cattle, particularly young animals.
- The most important parasites of grazing cattle are gut worms, lungworm and liver fluke.
- Grazing cattle should be monitored daily for clinical signs of parasitism: scour, (weight loss and coughing).
- Two months into the grazing season is an ideal time to check for gut worms (faecal egg counts) in young, weaned cattle, and to review parasite control strategies.
- Farm parasite control programmes should be put in place by the farmer in conjunction with their veterinary practitioner.

### Introduction

Parasites can have a significant impact on the performance and health of grazing beef cattle. The main parasites of importance during the grazing season are gut worms, lungworms (hoose) and liver fluke. Gut worms are present on all cattle farms in Ireland; lungworms and liver fluke are present on the majority of farms, with the prevalence of the latter highest in the west. There are over 20 species of gut worms which affect cattle, but only two important species are commonly encountered in Ireland, stomach worms of the *Ostertagia* species and worms of the *Cooperia* species that live in the small intestines. Infection with these worms causes the condition known as parasitic gastroenteritis (PGE) or worm scours. Young animals can experience severe clinical disease when infected with large numbers of gut worms, causing signs such as poor appetite, diarrhoea and reduced weight gain. Gut worms can also adversely affect performance in older cattle, including reduced live weight gain, delayed onset of puberty and lower conception rates.

The lungworm parasite is also a roundworm, similar to gut worms, however it completes its lifecycle in the lungs rather than in the gut. The clinical signs of infection are coughing and difficulty in breathing, especially when animals are being moved. Lungworm can result in death where serious infections occur. Fatalities due to lungworm can occur suddenly and in late summer, so careful monitoring of stock is essential.

Liver fluke is a flatworm that affects grazing cattle. Following ingestion the parasite penetrates the gut wall and moves to the liver where they can cause significant damage. Clinical signs in cattle include reduced appetite, failure to thrive, lower milk yield and poor fertility. Liver fluke rarely causes fatalities in cattle. Liver fluke has an intermediate host, the mud snail, in which it completes part of its lifecycle; as its name suggests, the snail is generally found in wet, muddy habitats.

### Monitoring for parasites

Monitoring for parasites is important and should form part of an overall herd health plan. It is essential to monitor cattle daily for clinical signs of parasitism, particularly for coughing at

grass. Two months into the grazing season is an ideal time to check for gut worms in young, weaned cattle, by performing faecal egg counts, and to review parasite control strategies. Monitoring can include:

- Observing cattle for clinical signs (scour, reduced weight gain, and coughing).
- Average daily live weight gain (ADG). If weaned grazing cattle less than 2 years have an ADG of 0.8 kg per day or more, it is unlikely that gut worms are a problem.
- Monitoring body condition score (BCS) in cows.
- Faecal egg counts (FEC): A sampling strategy should be discussed with the farm's veterinary practitioner.

## Gut worms and lungworms: control and treatment

### *Beef suckler calves - first grazing season*

Spring-born beef suckler calves are rarely affected by gut worms early in the grazing season, as they are suckling their mothers and have a relatively low grass, and therefore, egg intake. In addition, a milk-based diet appears to reduce the impact of gut worm infection. The greatest risk period is after weaning in late summer and autumn. Moving weaned calves to the cleanest available pasture will help control gut worms and lungworm during the period from weaning to housing. ADG and/or FEC can be used to monitor weaned calves and anthelmintic treatment used if reduced growth rates or high FECs are noted. An alternative approach to control parasites during the period from weaning to housing is to treat with a worm dose with persistent action at weaning.

Lungworm may cause problems in beef calves at any stage but coughing due to lungworm is most common in the second half of the grazing season, especially after weaning. Daily observation of calves for coughing is vital throughout the entire grazing season, as deaths due to lungworm can occur quickly. Treatment with an appropriate anthelmintic is recommended immediately if coughing is heard in calves. Doses that are active against gut worms will also cover lungworm. To prevent reinfection, calves should be moved from the affected pasture or an anthelmintic with persistent action should be used.

### *Weaned calves/yearlings - second grazing season*

Weaned autumn-born calves and spring-born yearlings in their second grazing season are susceptible to both gut worms and lungworms. They should be turned out onto the cleanest available pasture – ideally newly reseeded pastures or pastures not grazed by young stock in the last year. Monitoring weights at turnout and 2 months later to calculate ADG and conducting FECs two months after turnout will give a good indication of exposure to gut worms and response to any doses used early in the grazing season. Rather than the traditional approach of treating all animals at this time, an alternative is to treat only those with high FEC and/or low ADG and move them onto clean pasture. However, if clean grazing is not available, then a group treatment with an anthelmintic is recommended. A further FEC and calculation of ADG will be necessary approximately 6-8 weeks later or sooner if the initial FECs have been high. A longer interval may be allowed if a product with a persistent action of more than 4 weeks has been used. Silage aftergrass should be used as clean grazing, as it becomes available, later in the season. Further monitoring will be necessary in the autumn if cattle remain at grass. It is particularly important to ensure that replacement heifers do not receive any setbacks and parasite monitoring and control for this group is vital.

Lungworm can be a problem in the second and subsequent grazing seasons if insufficient immunity has been induced in the first grazing season or if immunity wanes due to a lack of challenge over a long period. Second grazing season cattle can be vaccinated for lungworm

prior to turnout on farms where lungworm in older cattle is a known problem. Although there are a few other reasons why cattle cough at grass, for example IBR, typically, hoose would be the primary suspect and any coughing cattle at grass should be immediately dosed.

## *Suckler cows and heifers/steers - third grazing season*

Older heifers and steers will generally have moderate to good immunity to gut worms and also to lungworm if they were infected in previous grazing seasons. Faecal egg counts and weighing is not as vital in this group as it is for younger cattle, but monitoring for clinical signs and satisfactory performance is still necessary. Heifers and steers may require a dose in the second half of the grazing season if clinical signs are evident or weight gain is unsatisfactory. Lungworm is not usually a problem but may be an issue if insufficient immunity has been induced in previous grazing seasons or if immunity wanes. Vaccination or dosing should be used as appropriate.

Suckler cows should have high levels of immunity to gut worms and lungworm as they will have been exposed to these infections over several years and generally will not require dosing for these parasites during the grazing season. Nevertheless, adult cattle should be included in a farm's monitoring programme for parasites. Monitoring for clinical signs, measurement of BCS and investigating ill-thrift are all important. Dung and additional samples (e.g. blood, nasal swabs- depending on clinical signs/differential diagnoses to be investigated) can also be taken by your veterinary practitioner to confirm the cause of any problems.

## **Liver fluke control and treatment**

Liver fluke can affect cattle of all ages, including cows. Fluke burdens can be monitored on beef farms by using a combination of dung sampling and the information provided from meat factories through Animal Health Ireland's "Beef HealthCheck" programme. The latter provides a detailed report, for each animal slaughtered, of the results of liver and lung inspection at post mortem, including the presence of fluke damage and pneumonia. Faecal egg counts can be carried out on dung samples, however, it takes approximately 12 weeks before fluke eggs appear in the faeces following infection. This means that egg counts should be done at least 3 months after turnout. Another test for fluke which can be carried out on dung samples, the fluke coproantigen test, is now available in some laboratories in Ireland. Reports show that the coproantigen test is more sensitive at diagnosing liver fluke than traditional egg counts and can diagnose infection before adult fluke have developed and eggs are produced.

Farmers can reduce the burden of liver fluke on pastures by improving drainage and fencing off wet land where possible. Measures to reduce poaching will also reduce snail habitats on farms. A strategic fluke dose in early- to mid-summer, designed to reduce the number of eggs being shed, can be useful on farms with a high fluke risk. The necessity of dosing cattle of any age for fluke at grass will vary depending on the farm fluke risk and rainfall. Farmers can assess their farms fluke risk by looking at:

- the suitability of the land for snail habitats – wet farms are at highest risk.
- the history of clinical cases of fluke on the farm.
- previous FEC results and liver results from meat factories.
- weather; mild wet weather increases the risk of fluke.
- fluke forecasts.

Table 1 on the following page gives summary of the anthelmintics and flukicides available in Ireland. A final decision on a parasite control programme should be reached in conjunction with the farm's veterinary practitioner.

**Table 1.** A guide to anthelmintic and flukicide treatments available in Ireland, their efficacy against important states of parasites and their persistency of action. Source: Animal Health Ireland's 'Parasite Control at Turnout' leaflet.

	Anthelmintic				Flukicide				Combination Treatments			
	Benzimidazoles	Levamisole	Macrocytic lactone	Oxantel	Miconazole	Ticlofenol	Salicylate	Oxydazole	Ivermectin + dorezol	Ivermectin + cephazone	Levamisole + tridibenzazole	Salicylate + Fenbendazole
Formulations	o	o/nl/po	inj/po <sup>1</sup>	o/nl	inj	o	o	o	inj	inj/po	o	o
ROUND WORM (Ostertagia)												
Adults	V	V	V						V	V	V	V
Larvae	V		V						V	V		V
Inhibited larvae	V		V						V	V		V
Persistency			V 3-6 weeks <sup>2</sup>						V <sup>3</sup>	V <sup>3</sup>		
Cooperia												
Adults	V	V	V						V	V	V	V
Larvae	V	V	V						V	V	V	V
Persistency			V <sup>3</sup> 2-4 weeks <sup>2</sup>					V <sup>3</sup>	V <sup>3</sup>			
LUNG WORM (Dictyocaulus)												
Adults	V	V	V						V	V	V	V
Larvae	V	V	V						V	V	V	V
Persistency			V 4-6 weeks <sup>2</sup>						V <sup>3</sup>	V <sup>3</sup>		
LIVER FLUKE (Fasciola hepatica)												
Adults	V (mature only)			V	V	V	V	V	V	V	V	V
Immature - Early						V <sup>3</sup>					V <sup>3</sup>	
Immature - Late				V <sup>3</sup>	V <sup>3</sup>	V <sup>3</sup>	V <sup>3</sup>	V		V <sup>3</sup>	V <sup>3</sup>	V <sup>3</sup>

<sup>1</sup> eprinomectin only as pour-on  
<sup>2</sup> except moxidectin  
<sup>3</sup> see data sheets for more details



# Dosing cattle and delaying the development of wormer resistance

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## Summary

What do I need to do to reduce the threat of wormer resistance on my farm without compromising on animal performance?

- Discuss with your vet how best to achieve this goal.
- Establish which products are effective on your farm.
- Check dosing equipment and ensure cattle are dosed according to their weight.
- Avoid overuse of anthelmintics and treat only as necessary.
- Do not dose cattle and then move them immediately onto 'clean' pasture. Keep them on the 'dirty' pasture for a couple of days after treatment.
- Not all animals in a group may warrant treatment. Consider only dosing the underperforming animals.
- Appropriate grazing management strategies should also be encouraged on farms.

## Introduction

In order to improve the profitability of Irish beef farming, expenditure on farm inputs needs to be controlled. As grazed-grass is the cheapest feed source available to Irish farmers, efforts are being focussed on further increasing the proportion of grazed-grass in the annual diet of cattle. However, this will lead to increased exposure to parasite challenge. Within grass-based production systems, the use of wormers (anthelmintics) is a critical element in ensuring animal performance is not compromised by parasitism. This is reflected in the sales of anthelmintics in Ireland where over one quarter of the expenditure in the animal health market is for the control of internal parasites (<http://apha.ie/AboutUs/Markets.aspx>).

Over the last number of years, there have been increasing reports of anthelmintic resistance (AR) in cattle-rearing countries. It is imperative that the lessons learnt in the sheep sector are translated to the beef sector before AR becomes a regular feature on cattle farms. Consequently, anthelmintics should be used as prudently as possible on Irish beef farms in order to delay the development of AR.

## What is anthelmintic resistance?

Anthelmintic resistance occurs when worms are able to withstand a normally effective dose of an anthelmintic. As this is a heritable trait, this ability to survive treatment is passed from one generation of worms to the next. It is now widely accepted that the worm genes coding for resistance appear to exist in all worm populations. As AR is an inevitable consequence of anthelmintic usage, cases of resistance tend to appear shortly after the introduction of a new anthelmintic onto the market. In Table 1, a number of commonly used anthelmintics and when resistance to them was first reported, are listed.

## Has anthelmintic resistance been detected on Irish cattle farms?

Anthelmintic resistance has been detected on some Irish cattle farms. However, as AR is a relatively new occurrence in the cattle industry worldwide, in contrast to the sheep industry, limited research has been conducted into determining its true extent on Irish cattle farms. Similar to other countries around the world, *Cooperia* was found to be the resistant genus on these Irish cattle farms. Although this gut worm is not as harmful to animal performance as *Ostertagia*, it does serve as a timely reminder that parasite control practices on cattle farms may need to be revised in order to prolong the effectiveness of anthelmintics.

**Table 1.** Introduction of anthelmintics and first reported cases of anthelmintic resistance

Anthelmintic	Commercially available	1st reported case of resistance	Species resistance reported in
Levamisole	1970	1979	Sheep
Fenbendazole	1975	1982	Sheep
Ivermectin	1981	1988	Sheep
Eprinomectin	1996	2003	Cattle
Doramectin	1993	2007	Sheep

## What is Refugia and why is anthelmintic resistance more common in sheep than in cattle?

Refugia refers to that portion of the worm population not exposed to anthelmintic treatment. This can include unexposed worm eggs and larval stages on pasture, as well as worms in untreated cattle. The greater the size of the population *in refugia*, the slower resistance tends to develop. This is the main reason why resistance occurs less frequently in cattle than in sheep, as cattle tend to be dosed less often than sheep, thereby resulting in less selection for resistance. Another reason for fewer reports of AR in cattle may be the shorter survival time of some cattle worms, which means that the resistant worms that survive treatment do not contribute much to the next generation of worms. A further consideration that may explain differences between the two species is the size of the faecal pat. The larger bovine faecal pat may confer a longer survival advantage to susceptible bovine worms thus, increasing the size of the population *in refugia*. Finally, compared to sheep, fewer studies have been conducted to detect resistance by cattle worms to anthelmintics.

## What practices increase the likelihood of anthelmintic resistance developing on my farm?

A number of factors can encourage the rate at which AR develops on farm. These include the following:

- *Excessive frequency of anthelmintic treatment or incorrect volume of dose administered.*

Every time a dose is given to an animal there is selection for resistance. This is because the only worms that survive in the animal post-treatment will be resistant ones. As a result, only eggs from resistant worms will be passed in the faeces from the animal for the subsequent few weeks as it takes approximately three weeks from the time infective larvae are picked up from pasture, develop into adult worms, and start producing eggs. Therefore, in animals that are treated too frequently (every 3-4 weeks), adult worms susceptible to the dose won't get a

chance to establish themselves and produce eggs. Under-dosing is another significant factor contributing to the development of resistance as this allows partially resistant worms to survive treatment. Under-dosing can be the result of faulty equipment, poor dosing technique (dosing into the mouth as opposed to over the back of the tongue) or administration of insufficient anthelmintic to the animal relative to its actual live weight.

- *Purchase of cattle carrying resistant worms.*

Purchasing cattle carrying resistant worms can result in the introduction of resistant worms onto a farm especially where these animals are not correctly treated and managed on arrival.

- *Size of the refugia-based population.*

The size of the worm population *in refugia* is also very important and it can be affected by frequent dosing. Another consideration might be prevailing weather conditions, particularly dry conditions which do not aid the survival of free-living larval stages on pasture.

- *Speed at which animals are re-infected after dosing.*

The speed at which animals are re-infected after dosing also dictates the rate of resistance development. This is dependent on factors such as the level of pasture contamination that animals experience following dosing, the type of dose given (long- or short-acting) or if the animal is relatively immune to re-infection. The traditional 'dose and move' system where animals are typically dosed and moved straightaway to clean pasture is now regarded as highly selective for AR as the only worms that survive treatment will be resistant ones and these will form the basis of the worm population in the new pasture.

## **Is there any way of finding out what wormers work on my farm?**

Yes. One of the simplest ways is to conduct a drench test. This is where 10 animals are dung sampled a number of days post-treatment - 7 days for levamisole and 14 days later if a benzimidazole (e.g. white drenches) or macrocyclic lactone (e.g. ivermectin, doramectin and eprinomectin) is used - to determine their faecal egg counts. The test can be further improved by also sampling animals on the day of treatment to determine their faecal egg counts. This test is only an indication of how effective treatments are; it cannot be used to definitely state that resistance is present. A more formal approach to testing for the presence of AR is to conduct a faecal egg count reduction test where multiple anthelmintic classes are tested together.

## **How do I reduce the risk of resistance becoming a real problem on my farm?**

First of all, discuss with your vet how best to achieve this goal.

- Establish which products are effective on your farm.
- Ensure a proper quarantine strategy for any purchased livestock. This involves using products effective against all worm types in purchased stock, both susceptible and resistant. Purchased stock should be held off pasture for 48 hours after treatment and then should be turned out onto contaminated pasture. Consult your vet on which products to use.
- Check dosing equipment and dose according to the heaviest animal in the group. If there are large differences in live weights between animals in a group, maybe split into two groups and dose according to the heaviest in each category.

- Avoid overuse of anthelmintics and treat only as necessary. *Do not dose by the calendar.* Monitoring of faecal egg counts and animal performance should be used as aids to decide on treatment. *It is important not to rely on a single indicator to decide when treatment is necessary.* For example, calves in the first grazing season may be scouring but it may not always be entirely due to stomach and gut worm challenge. It may be due to other factors such as coccidiosis, or there might be an underlying copper deficiency problem. Therefore, it is important that where possible, animals are dung sampled so as to decide on the need for anthelmintic treatment.
- Practices such as dosing cattle and immediately moving them onto 'clean' pasture are discouraged. Consider dosing a few days before the move to 'clean' pasture.
- Not all animals in a group may warrant treatment. Consider only dosing the underperforming animals as there may be no benefit in dosing animals that are performing well.
- Grazing management strategies should be used where possible. This can involve the movement of animals onto 'clean' pasture such as hay or silage aftermaths.

## **Should I use the same dosing programme for my spring-born suckler calves that I have for my spring-born dairy-to-beef calves?**

No. In the first grazing season there will be big differences in the worm challenge experienced by spring-born suckler beef calves when compared to their dairy-to-beef counterparts. In contrast to suckler beef calves, dairy-to-beef calves will typically experience worm challenge earlier in the grazing season. This is a result of the difference in production systems between the two. Given that milk generally accounts for a substantial proportion of the diet of a suckler calf in the first three months of life, the corresponding relatively low grass consumption means these calves are not exposed to large numbers of infective larvae early in the grazing season. There is also an added benefit in that the infectivity of the pasture will not increase greatly over the course of the grazing season, when compared to the pasture grazed by their dairy-to-beef calf counterparts, as only relatively small numbers of egg-laying adult worms develop in these calves. However, calves born to dams with poorer milk yields will potentially consume greater volumes of herbage and therefore, will be more exposed to parasite challenge earlier in the grazing season.

As the grazing season progresses, dam milk yield will decline and herbage consumption by the suckler calf will increase. Therefore, typically for spring-born suckler beef calves, the main worm challenge is most commonly experienced in and around weaning time when calves are consuming appreciable quantities of grass containing infective larvae. Farmers need to be aware that although challenge with lungworm typically also occurs in these calves around weaning, given its unpredictable nature, disease caused by lungworm can occur earlier in the season.

In contrast to spring-born suckler calves, autumn-born calves that are turned out to pasture in spring will be consuming higher quantities of grass that will make them liable to parasite challenge much earlier in the grazing season compared to their spring-born counterparts.

## Herd health planning

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### Summary

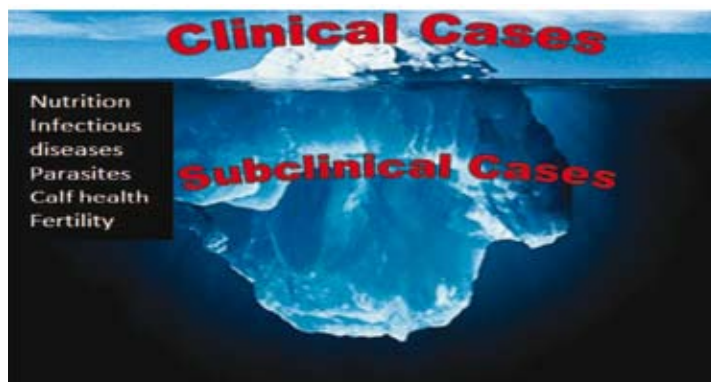
- Herd health planning is farm specific.
- Put together a 'herd health team'; farmer, vet, Teagasc advisor, nutritionist and others.
- Use clinical illness to help focus on key areas for disease prevention.
- Segment disease areas for a systematic approach.
- Examine the flow of events on the farm, identify key areas of risk and decide how to manage these risks.
- Build in targets and monitor the key health indicators in the herd.
- Healthy herd - healthy food - healthy profit.

### Introduction

The farmer's objective is to increase farm profit and avoid clinical 'disasters'. More specifically, the farm herd health focus is to optimise animal health and welfare, reduce clinical and subclinical disease and maximise animal production. The vet has a key role in seeking and maintaining efficiency on-farm. The mindset change required from farmers (and vet!) is to consider the veterinary practice as a key partner in maintaining animal health equilibrium on the farm while maximising production. What clearly does not work is the vet being called to treat chronic clinical cases on-farm that are not only expensive to treat but will also have a very poor treatment outcome. The effects of herd health problems on the profitability of suckler beef farms are manifested through animal mortality, ill-thrift, cost of treatment, cost of prevention and additional labour. Considering that a target of 0.95 calves weaned per female mated is the desired production goal, then there is plenty of scope for improvement.

### Subclinical disease

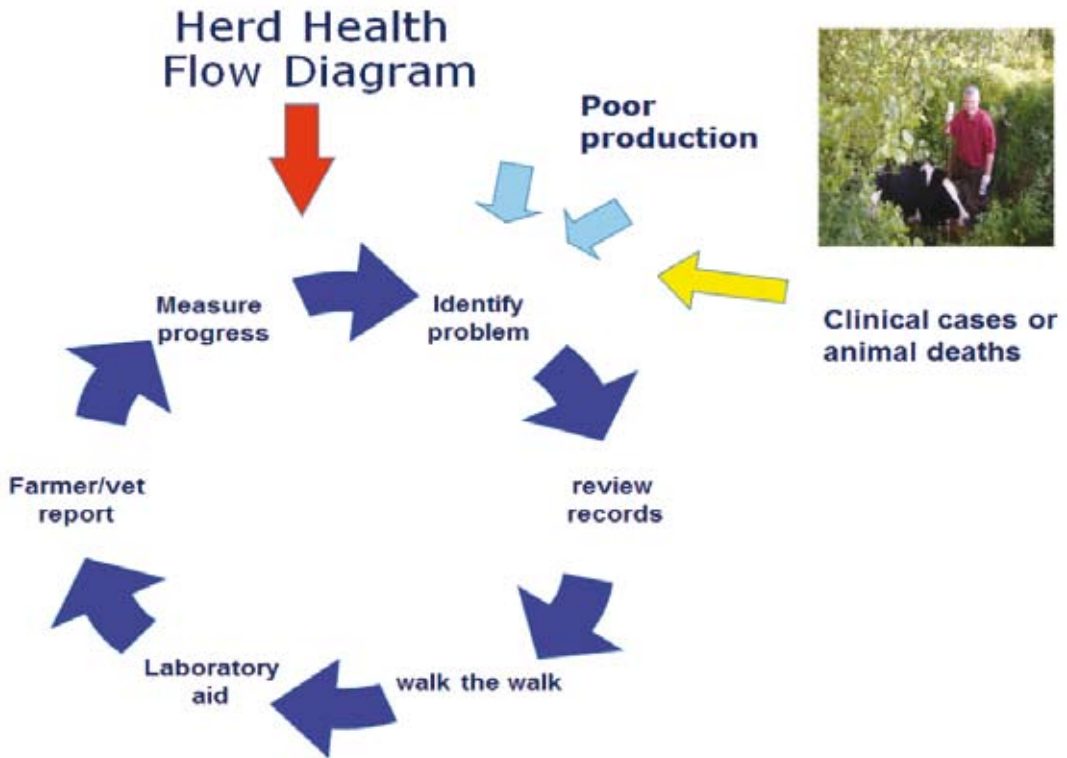
In Ireland, most veterinary practices still have a considerable caseload of clinically ill animals. The reality is that there is also a significant loss of production in other animals in the herd with subclinical diseases such as, viral pneumonia, parasites and others (Figure 1).



**Figure 1.** Clinical and subclinical diseases



However, the clinical cases can be used as the gateway into the herd health cycle by helping to identify animal health issues on the farm (Figure 2).



**Figure 2.** Steps to identifying animal health issues on livestock farms

Therefore, the veterinary clinician becomes a herd health practitioner as he/she takes a 'wide-angled' approach on-farm. For example, if a vet is on call in the month of March and treats a calf or two with pneumonia, surely it is the norm that: other calves are assessed; samples are taken for the laboratory; a detailed history is taken of similar problems in the previous weeks, months or years; bedding, ventilation, and hygiene conditions are considered; and, colostrum intake is monitored. What begins as a simple clinical event has developed into a herd health plan facilitated by the vet with the farmer.

## Herd health – where to begin

Ask 'what were the main disease issues that have affected my farm over the previous year(s)?' With the vet, discuss how these can be prevented. You could also look and segment other key areas of disease and production (Figure 3). The likely areas to focus on are:

1. Calf health
2. Infectious diseases (the big six; BVD, IBR, *Salmonella*, *Leptospira*, *Neospora* and *Johnes*)
3. Fertility
4. Parasites
5. Nutrition (macro and micronutrients)

There are significant advantages to using a systematic approach to disease prevention. The 'herd health team' or Hazard Analysis and Critical Control Point (HACCP) team should include the farmer, vet and key farm advisers such as the nutritionist or Teagasc advisors. Good Farming practices (GFPs) form the bedrock. Suitable GFPs include:

1. Hygiene (in the calf housing, calving area, milking parlour and cow cubicles).
2. Training on-farm, e.g. calving technique, medicine usage, body condition scoring.
3. Medicine usage, and storage, considering the withdrawal periods and the appropriate records. The main areas for veterinary involvement include vaccine protocols and calendars, anthelmintic usage and vaccination protocols.
4. Farm structures and premises. It is necessary to have suitable animal housing in terms of design, ventilation and cleanliness. Appropriate cow and calf housing are required.

Consider a herd health plan to manage calf health. When good farming practices are in place, the team (farmer, vet and advisor) initially considers the flow of events on farm (Figure 3), beginning with the dry cows and then calving, feeding and growing animals. We know the major risks for calf health and in particular scour and pneumonia. The team asks a key question at every step: *'How can we reduce the likelihood of disease having an impact at that particular stage?'*

Therefore, at the dry cow stage the team considers the following:

- What is the body condition score of the dry cows?
- Are there suitable dry cow minerals, including iodine, in the diet?
- Are parasites under control in the dry cows?
- Is the hygiene of the dry cows and their environment maintained to an acceptable standard?
- From previous experience, is it necessary to use scour vaccine to prevent calf disease?

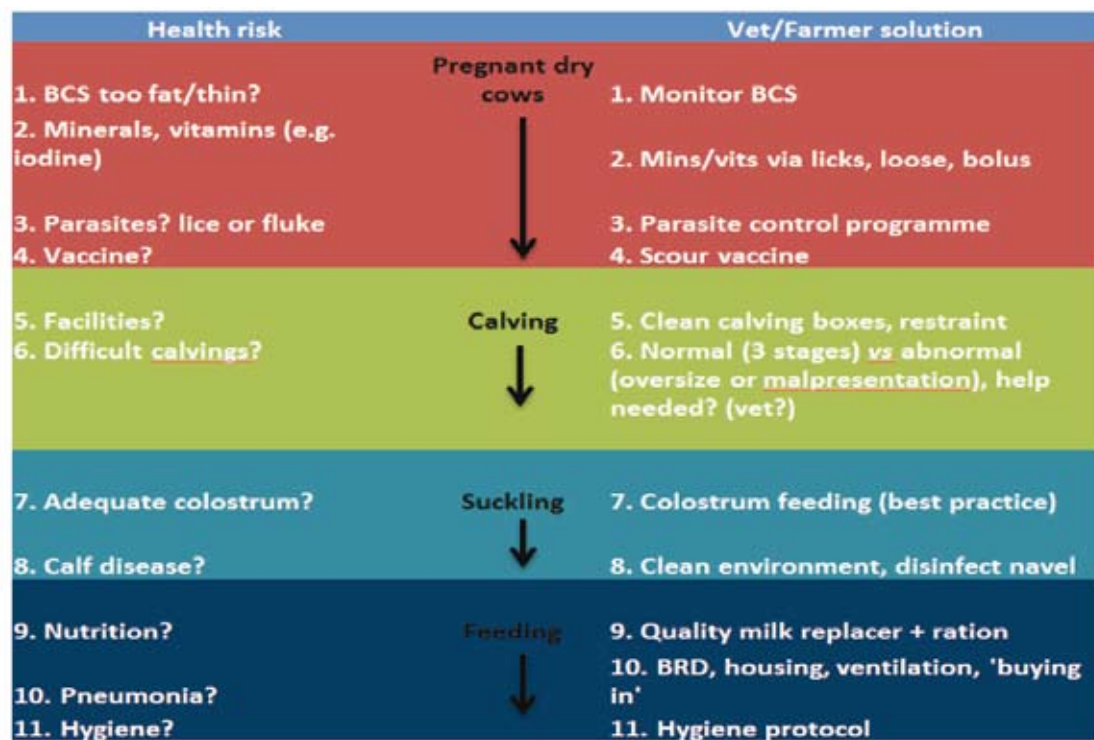
Considering these aspects may prompt actions and solutions at this 'dry cow' stage to reduce the likelihood of scour and calf disease. The vet becomes involved here in helping to monitor the effectiveness of these controls, giving advice about body condition scoring, hygiene standards and vaccination programmes.

## Managing disease risk

Herd health advice by the vet provides a risk analysis tool where the farmer and vet, and others, identify key risk management practices.

- What is the likelihood of introducing viral pneumonia from bought in animals?
- How much will it cost to improve the calf shed ventilation and design?

The farmer may question the effort, finance and labour of some of these risk management practices and a key role for the vet is to provide him with guidance. For example, if the probability of a Cryptosporidia clinical outbreak is high and the consequences are reasonably significant, then the farmer understands that it would be wise to invest in its prevention. Most farmers in addition to using their veterinary practice for fire-brigade services - coming out and treating sick cases - also plan out a strategy for the year, looking at key areas: nutrition, calf health, fertility, parasites, infectious diseases - the high-risk diseases that are going to be the most important on the farm.



**Figure 3.** Flow of events on farm

## Public health benefits in using HACCP for herd health

There are three main benefits of using HACCP to control herd health and, for example, calf disease on the farm:

1. As there is less calf disease, there will be a significant reduction in antibiotic use. In particular, use of antibiotics in enteric disease may encourage sharing of resistance. Therefore, reduced antibiotic usage in the calf will result in a decreased pressure for antibiotic resistance in both animals and the environment;
2. Most scour pathogens are zoonotic i.e. affect humans: *E coli*, rotavirus, Cryptosporidia, *Salmonella*. These may cause illness to humans through direct contact or further down through the food chain. A first, and key, step is to control these zoonoses on farm; and
3. HACCP and GFP are food safety management systems that are understood by international markets. This is especially important as consumers and retailers are very keen to interrogate food safe systems pre-farm gate.

## Conclusion

More than ever, Irish farms need the traditional clinical and obstetrical skills of the vet. In addition, they require a practitioner who can: firstly, systematically investigate the background to clinical disease; secondly, in conjunction with the farmer, provide solutions and targets that are meaningful and give results; and finally, be involved in monitoring the health of the farm for early intervention and preservation of a stable and calm productive herd.



# **Technology Village:**

## **Beef Systems – Targets and Planning**



# Teagasc suckler beef research and demonstration herds

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## Summary

- The Derrypatrick Herd at Grange is a 100-cow research demonstration herd with the objective of evaluating alternative suckler calf-to-beef production systems.
- The current study involves a comparison of late-maturing and early-maturing terminal sire breeds and a comparison of steer, heifer and bull finishing systems.
- Animal performance levels were high in all three suckler beef finishing systems.
- The Newford Herd was established by Dawn Meats and Teagasc in 2015 in association with partners the Irish Farmers Journal and McDonalds and aims to:
- Demonstrate the most innovative technologies in beef production to improve productivity and profit levels on Irish farms.
- Transfer knowledge regarding the efficient operation of a grass-based suckler farm onto a greater number of beef farms.
- Demonstrate best practice in management and, environmental and animal welfare sustainability.

## The Derrypatrick Herd

The Derrypatrick Herd at Grange is a 100-cow research demonstration herd on 65 ha of intensively-managed grassland. The primary objective of this herd is to evaluate alternative suckler calf-to-beef production systems. The current study involves a comparison of late-maturing (Charolais and Limousin) and early-maturing (Angus) breed terminal sires (see Table 1) and a comparison of steer, heifer and bull finishing systems. The current study began in spring 2013; the existing Derrypatrick Herd was bred to either early- or late-maturing breed sires. All purchased heifer replacements were selected on the basis of high Replacement Index. Because of the change in market requirements, all bulls (both late- and early-maturing) were slaughtered at less than 16 months of age. The expected slaughter ages of the steers from the

**Table 1.** Star rating of sires of 2013 born Derrypatrick progeny

Stock bulls	Star rating across breed	Star rating within breed	Progeny born per bull	Terminal Index value	Carcass sub-index value
AA 1	**	****	9	67	+13 kg
AA 2	****	*****	19	111	+25 kg
AA 3	***	*****	16	97	+20 kg
Average	3.2	4.8	44	96	+20.7 kg
CH 1	*****	*****	18	147	+34 kg
CH 2	***	*	18	88	+31 kg
LM	**	*	12	87	+22 kg
Average	3.5	2.5	44	109	+29.9 kg

early- and late-maturing breed sires were 22 and 24 months, respectively. The corresponding expected slaughter ages for the heifers were 18 and 20 months. In this paper the results from the first year of a three-year study are presented.

## *Animal performance at slaughter*

The performance of the steers, heifers and bulls at slaughter for both the early- and late-maturing genotypes is summarised in Table 2. The late-maturing breed steers and heifers had greater carcass weight (+22 kg and +28 kg, respectively) and required longer to finish (+78 days and +57 days, respectively) compared to their early-maturing breed counterparts. Age and live weight at slaughter were similar for the early- and late-maturing breed bulls, but the carcass weight of the late-maturing bulls was 15 kg greater due to a higher kill-out percentage (57.2% and 59.5% for early- and late-maturing breeds, respectively). Carcass conformation score was greater for the late-maturing bulls, whereas carcass fat score was greater for the early-maturing animals.

**Table 2.** Slaughter traits for progeny of the Derrypatrick Herd in 2015.

Gender	Breed type	Age (days)	Weight (kg)	Conf. score <sup>1</sup>	Fat Score <sup>1</sup>	Carcass weight (kg)	KO (%)	Price (€/kg) <sup>2</sup>
Steer	Early	585	649	7.69	9.46	361	55.6	4.15
Steer	Late	663	668	8.45	8.09	383	57.4	4.05
Heifer	Early	570	574	7.82	10.64	311	54.2	4.19
Heifer	Late	627	596	8.60	8.48	339	57.0	4.24
Bull	Early	465	664	9.38	8.85	380	57.2	4.35
Bull	Late	469	664	10.30	7.20	395	59.5	4.41

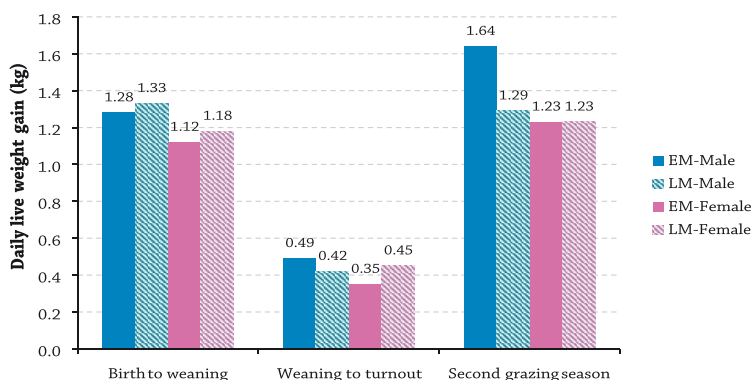
<sup>1</sup>Conformation and fat scores on a 1-15 scale. <sup>2</sup>Price includes early-maturing 'bonus'.

Average birth weight was 4 and 3 kg greater for the late-maturing breed bull and heifer calves, respectively, compared with their early-maturing counterparts.

## **Implication of genotype for feeding system**

The lifetime concentrate consumption of the early- and late-maturing breed steers, heifers and bulls from the Derrypatrick Herd are summarised in Table 3. Steers and heifers were

**Figure 1.** Average daily live weight gain of early-maturing (EM) and late-maturing (LM) genotype male and female cattle during the key stages of the production lifecycle. Male = bull until weaning, and steer thereafter.



slaughtered based on target fat score and those that did not meet the required level of finish (fat score, 3=) at the end of the second grazing season were housed and finished on a grass silage and concentrate diet. At the end of the grazing season 92% of the steers and 100% of the heifers in the early-maturing genotypes were slaughtered before housing. In contrast, 36% and 48% of the corresponding late-maturing genotype animals were slaughtered before housing. The quantity of concentrate supplement consumed per animal was 529 and 360 kg less for the early-maturing breed steers and heifers, respectively, compared to their late-maturing contemporaries. For the bulls, the amount of concentrate supplement consumed per animal was 156 kg higher for the early-maturing compared to the late-maturing breed type. The results indicate that both production system (i.e. steers, heifers or bulls) and animal genotype (i.e., early- or late-maturing) have a significant effect on the composition of the annual diet in terms of proportions of grazed grass, silage and concentrates.

**Table 3.** Concentrate supplementation level and slaughter date.

Gender	Breed-type	Concentrate fed (kg)	Slaughtered off pasture before second winter (%)
Steer	Early	293	92%
Steer	Late	822	36%
Heifer	Early	195	100%
Heifer	Late	555	48%
Bull	Early	2,015	n/a
Bull	Late	1,859	n/a

The preliminary results from this study highlight a number of key findings. Firstly, very high animal performance was obtained in all three suckler beef finishing systems. Secondly, early-maturing genotypes could significantly reduce farm fixed costs as they don't require housing for a second winter, albeit with lower levels of beef output.

The results reported here are from the first year of a three-year study, and the results for the following two years are required before definitive conclusions can be drawn. A detailed financial appraisal needs to be completed, including sensitivity analysis of beef prices, concentrate costs and farm pasture utilisation.

## The Newford Herd

The Newford Herd was established by Dawn Meats and Teagasc in 2015. The 100-cow suckler calf-to-beef demonstration herd is located at Teagasc in Newford, Athenry with farm manager, Matthew Murphy, charged with the day-to-day running of the herd. The overriding aim is to generate a high profit grass-based suckler calf-to-steer and -heifer beef production system. There is also a focus on quantifying the labour required to operate a 100-cow unit, while also developing benchmarks and production targets for a herd utilising a breeding policy and cow type that differs from the majority of Irish suckler enterprises. This is a new initiative to transfer knowledge on the efficient operation of a grass-based suckler farm onto a greater number of beef farms. A number of objectives have been set by Dawn Meats and Teagasc with partners the Irish Farmers Journal and McDonalds:

- To establish a 'stand-alone' 100 cow spring-calving suckler unit to demonstrate the most

innovative technologies in beef production and to improve productivity and profit levels on Irish farms.

- To demonstrate the potential of a moderately-large suckler beef farm to provide a viable family farm income when operated to the highest level of technical efficiency.
- To develop and demonstrate world-best practice in suckler beef farm systems in terms of management, and environmental and animal welfare sustainability, while setting new benchmarks for achievable performance and aid in the transfer of the successful technology to beef farms throughout Ireland.
- To provide additional training and educational opportunities for advisors and suckler beef farmers.

## *Farm overview*

The farm is located at Newford, Athenry on a stand-alone unit close to the Teagasc Mellows Campus. Farm size is 55.8 ha (138 acres) and it is split into 3 blocks. Much of the land can be described as being free-draining with about 8 ha (20 acres) requiring drainage works to be carried out. Ten ha (25 acres) of the farm were reseeded in October 2014 and a further 9 ha (17.5 acres) were reseeded in Spring 2015. In the forthcoming years it is envisaged that 10% of the land area will be reseeded each year. Perennial ryegrass monocultures Glenveagh, Abergain, Aberchoice and Abergreen were sown and their performance will be analysed over the duration of the project. Soil fertility is quite good with an average pH 6.14; 97% of the farm is in Index 3 or 4 for phosphorus and 51% of the farm is in Index 3 or 4 for potassium. Cattle will be housed in slatted floor accommodation during the winter months with straw-bedded loose housing being used to house some of the weanlings. Some existing sheds were converted in spring 2015 to calving pens and loose pens for cows at calving time.

## *Farm system*

The farming system is a suckler calf-to-beef system with steers finished at 20-24 months and heifers finished at 20-22 months. When the first production cycle of animals is completed, it is projected that heifers and steers will be finished at 320 and 350 kg carcass weight, respectively. The farm will be stocked quite high at 200 kg organic nitrogen/ha (approximately 2.7 LU/ha). The system is projected to deliver a gross margin of approximately €1190/ha by 2020. Cow type is an early-maturing (Angus/Hereford) crossbred from the dairy herd with high Terminal Index bulls being used to produce progeny to be slaughtered. Replacements will continue to be purchased from the dairy herd for the duration of the project. Replacement heifers will be purchased as calves, contract-reared and then brought back onto the farm close to calving at 24 months of age. While some may question this replacement strategy and cow type it is important to be cognisant that, with the expansion in the dairy herd, this type of replacement will be readily available to suckler farmers and this demonstration farm will be able to show their suitability or non-suitability for a suckler to beef system. Contract rearing of the replacement heifers will allow the farm generate maximum output, while keeping the system simple with a minimum of stock groups grazing on the farm. In 2016 calving took place from 20 February to 30 April. As the farm is managed by one labour unit, minimising calving difficulty is extremely important. When selecting terminal sires and a limit of <7% calving difficulty was set. Other criteria for AI sires were 5 stars on the Terminal Index, >30 kg carcass weight and >70% reliability on the calving index.

Over the coming years regular updates on progress being made on the farm will be provided on the farms website [www.newfordsucklerbeef.ie](http://www.newfordsucklerbeef.ie) and also through Teagasc and Irish Farmers Journal publications.

## Dairy calf-to-beef production: a real alternative

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### Summary

- Research at Teagasc, Johnstown Castle has evaluated alternative production systems and finishing strategies for Holstein-Friesian bulls and steers and early-maturing breed steers and heifers from the dairy herd.
- Rearing males as bulls has inherent efficiencies due to their higher growth potential but the profit generation of these systems is highly sensitive to changes in concentrate price.
- Farmers must also be aware of market preferences with regard to bull beef production systems and, therefore, close communication with meat processors is essential.
- By increasing the utilisation of good quality grazed pasture in place of concentrate input and focusing on a high output per hectare the profitability of the production system can be increased.
- Acceptable carcass weights and grades can be achieved by finishing steers and heifers at pasture either at the end of the second grazing season or during the third grazing season.
- Future research at Johnstown Castle will evaluate the effect of stocking rate on animal performance and farm profitability.

### Introduction

The most recent figures from the Central Statistics Office show that the national dairy herd has expanded to over 1.2 million cows. The majority of these cows (57%) are bred to dairy sires, 30% bred to early-maturing breed sires (18% Angus and 12% Hereford, respectively) and approximately 9% are bred to continental breeds (Limousin, Belgian Blue, Simmental and Charolais). Approximately 340,000 male dairy bred calves will be born in 2016. Currently, steer beef dominates beef production in Ireland, while bull beef represents approximately 20% of the national male slaughterings (Bord Bia, 2016). Given the low value for male dairy calves this spring and the use of sexed semen on some dairy farms, it is possible that there may be an increase in the proportion of beef crossbred calves coming from the dairy herd.

Research carried out at Teagasc Johnstown Castle has, to date, focused on modifying/establishing blueprints of production for Holstein-Friesian and early-maturing dairy beef crossbred calves (males and females). While all systems are focused on incorporating grazed pasture into the animals' feed budget, alternative strategies are being investigated to examine the performance of finishing animals on grazed grass diets. The key drivers of profitability in all beef production system are stocking rate and carcass output. Therefore, producers must identify production systems specific to their farm that maximise stocking rate and make best use of the facilities available on farm.



## Current research at Johnstown Castle

In 2010 research began on dairy calf-to-beef production systems at Teagasc Johnstown Castle. Since then studies have been carried out to investigate the effects of concentrate supplementation during the first season at pasture, to explore opportunities for reducing the reliance on concentrates during the finishing period and to investigate methods of optimising pasture utilisation within production systems. This research has evaluated a range of production systems for both dairy bred bull and steer and early-maturing (Angus and Hereford) steer and heifer production systems. Current research at Johnstown Castle is evaluating Holstein-Friesian 15-month and 19-month bull systems and, 21-month and 24-month steer production systems. Alternative finishing strategies are also being investigated for early-maturing breed dairy crossbred beef production systems. The production systems below represent the main blueprint systems arising from the research carried out at Johnstown Castle over the past six years.

### 1. Male dairy calf-to-beef production systems

**15-month Holstein-Friesian bull system:** Current market specifications dictate that dairy bulls must; be slaughtered at less than 16 months of age; achieve a carcass weight of 270 kg or greater; achieve a carcass conformation score of O= or greater; and achieve a carcass fat score of 2+ or greater. Previous research showed that these targets are difficult to achieve. Central to achieving these market specifications is a calf that has good weight for age. Results from Johnstown Castle demonstrated that spring-born Holstein-Friesian calves that gained 0.9 kg/day during their first season at pasture and weighed approximately 250 kg at housing, can reach the target weight specification for this system. Bulls were finished on an *ad libitum* concentrate diet and grew at approximately 1.4 kg/day. Total concentrate input for this system was 1.8 tonne dry matter (DM). Research over the last number of years in Johnstown Castle has shown that approximately 39% of the dairy bulls slaughtered at 15 months of age met the required carcass weight with 52% achieving the required fat score. More recently, in 2015, Holstein-Friesian bulls slaughtered at Johnstown Castle had an average carcass weight of 283 kg and a conformation score of O+ but were under-finished, with an average fat score of 2=.

**19-month Holstein-Friesian bull system:** The blueprint for bulls slaughtered at 19 months of age included a 100-day period at pasture in the first part of the second grazing season followed by a 100-day indoor finishing period on an *ad libitum* concentrate diet. Bulls were 416 kg at housing and 613 kg live weight at slaughter. Carcass weight was 325 kg with conformation and fat scores of O+ and 3-, respectively. Concentrate input for this system was 1.2 tonne DM.

Alternative pasture-based finishing strategies were evaluated for the production of 19-month dairy bulls. Bulls were either supplemented with 5 kg concentrate DM per head daily for 100 or 150 days pre-slaughter. Bulls finished for 150 days at pasture had a carcass weight of 294 kg with conformation and fat scores of O= and 2=/+ , respectively. Bulls finished over a 100 day period achieved a carcass weight of 289 kg and identical conformation and fat scores to the 150 day finishing group.

**21-month Holstein-Friesian steer system:** Finishing steers at the end of the second grazing season represents a viable alternative to indoor winter finishing. For this system to be successful steers must have a good live weight gain throughout their lifetime. Typically, Holstein-Friesian steers were turned out to pasture for the second season at 326 kg live weight and by mid-September were 483 kg. The blueprint for finishing steers in this system is 5 kg concentrate

DM per head daily for 60 days pre-slaughter. Additionally, a longer concentrate feeding duration of 110 days pre-slaughter was investigated at Johnstown Castle. Results showed that steers finished over 60 days had a carcass weight of 275 kg with carcass conformation and fat scores of P+ and 2=/+ , respectively; those finished over 110 days had a similar carcass weight (276 kg) and conformation and fat scores.

*24-month Holstein-Friesian steer system:* Finishing steers at 24 months of age indoors on a combination of grass silage and 5 kg concentrate DM per head daily represents the traditional system where performance is predictable and repeatable. Steers were turned out to pasture for the second season at 321 kg live weight and housed the following November at 538 kg. Live weight gain during the indoor finishing period was 0.9 kg/day. Live weight at slaughter and carcass weight were 612 and 310 kg, respectively, and carcass conformation and fat scores were O- and 3=, respectively. Concentrate input during the finishing period was 440 kg DM.

## 2. Early-maturing breed production systems

*19-month heifer system:* Spring-born, early-maturing breed heifers can be finished off pasture from September to November with 2.5 kg concentrate DM supplementation daily for 60 days pre-slaughter. Target carcass weight is 235 kg. Carcass conformation and fat scores were O= and 3-/, respectively. Results from Johnstown Castle have shown that this target weight is repeatable and achievable.

*21-month heifer system:* This system is suitable for February-born heifers as they can be finished off pasture at the end of the second season with 2.5 kg of concentrate DM supplementation daily for 60 days pre-slaughter. Heifers in this system achieved a carcass weight of 247 kg and carcass grades of O=3=. Finishing heifers indoors is less profitable than pasture-based finishing. Also, early-maturing breed crossbred dairy heifers that were finished indoors during their second winter were over-fat at slaughter. Results showed that all spring-born, early-maturing breed crossbred dairy heifers were fit to be slaughtered off pasture before their second winter.

*21-month steer system:* Early-spring-born (January/February) steers were slaughtered off pasture in November at 21 months of age after receiving 2.5 kg concentrate DM supplementation per head daily for 60 days pre-slaughter. Live weight at slaughter and carcass weight were 525 kg and 274 kg, respectively. Carcass conformation score was O= and carcass fat score was 3+.

*23-month steer system:* The 23-month steer production system represented the traditional system for this breed type. Typically animals were finished indoors on grass silage offered *ad libitum* supplemented with 5 kg concentrate DM per head daily. Live weight at slaughter was 607 kg and carcass weight was 308 kg. Carcass conformation score in this production system was O+ and carcass fat score was 3+.

*26-month steer system:* Steers were housed and stored over the second winter on a grass silage only diet. These animals were turned out to pasture for a third grazing season and were slaughtered in June at 26 months of age. Live weight at slaughter was 621 kg and a carcass weight of 322 kg was achieved. Carcass conformation score was predominately O+ and carcass fat score was 3+.

## Future research

Future research at Johnstown Castle will investigate the impact of stocking rate and the influence of sire genetic merit on progeny performance. Three farmlets representing low, medium and high stocking rates have been established to determine the optimum stocking rate for dairy calf-to-beef heifer and steer systems. The systems of production will consist of the most profitable heifer and steer systems on a per hectare basis evaluated to date. Half of the heifers in the study will be finished off pasture in September and the remaining heifers will be slaughtered in November with approximate slaughter ages of 19 and 21 months, respectively. Similarly, steers will be finished off pasture; half in November at the end of the second grazing season and half in June during the third grazing season, at approximately 21 and 26 months of age, respectively.

Progeny from Angus, Hereford and Limousin sires of diverse genetic merit for calving ease and gestation length will be included in the study. Performance of the progeny from these sires will be evaluated.

## Conclusions

Research evaluating contrasting finishing strategies is identifying the optimum production systems for Holstein-Friesian bulls and steers and, early-maturing steers and heifers from the dairy herd. Despite bull production systems having the potential to achieve higher outputs per hectare compared to steer production systems, price discounts on bulls greater than 16 months of age relative to steers, greatly reduces the profitability of these systems. Steer production represents a much lower risk option to producers as these systems are not as reliant on concentrate input and are thus, less sensitive to fluctuations in concentrate input costs, compared to bull production systems. Central to any successful dairy calf-to-beef production system is good grassland management and ensuring optimum animal growth with maximum pasture utilisation.



## Organic beef production

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### Summary

- Organically managed land now occupies approximately 2% of the total utilizable agricultural area (UAA) in the country, representing over a doubling in area in the past decade.
- 70% of organic farmers are involved in cattle production.
- Organic beef farming can be a profitable system of farming.
- In recent years, prices for organic beef in factories have generally been approximately 15 to 20% above conventional prices.
- Ensuring high animal health and welfare standards is a fundamental ethos of organic principles.

### Introduction

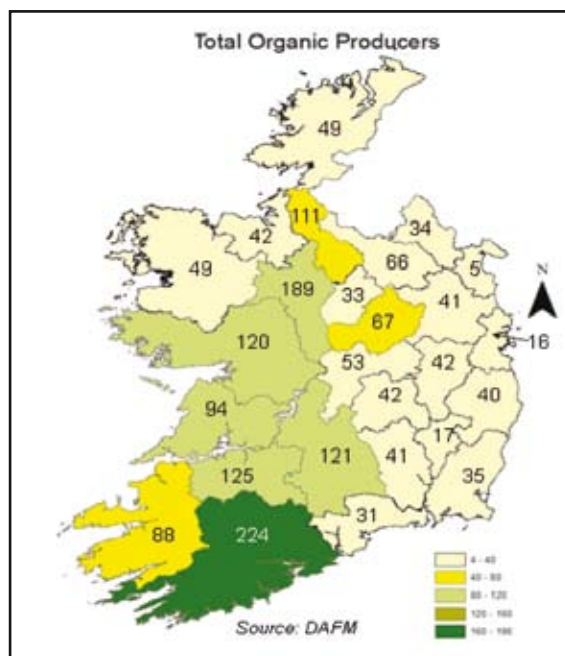
Organic production is defined as “an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes”.

At farm level in Ireland, the organic sector has experienced a large influx of new farmers in recent years with 1,800 farmers now farming organically, including approximately 600 who entered conversion in 2015. About 70% of organic farmers are cattle farmers. Organically managed land now occupies approximately 2% of the total utilizable agricultural area (UAA) in the country, which is over a doubling in area compared to the previous decade. This compares with an average of 5.7% of UAA across the European Union.

### Organic beef farming in Ireland

According to DAFM, in mid-2015 there were over 1,300 organic cattle farms in Ireland, most of whom were suckler farms (~900). In total, there were over 59,000 cattle, including 19,000 suckler cows, farmed organically. This represents an increase of 65% in cattle farms and an increase of 100% in cattle numbers since 2008. Figure 1 shows the location of all organic farmers in Ireland. In 2012, there were over 9,000 organically farmed cattle slaughtered in Ireland by approximately 500 farmers. Figure 2 shows the number of organic cattle disposals in 2012 per month through factories, abattoirs and exported live. With the relatively large influx of new organic farmers entering conversion in 2015, it is expected that these figures will rise by about 40-50% by 2018.

There is a perception that organic farming is difficult, contains a lot of ‘red tape’, is demanding on labour and returns low levels of productivity. The reality is quite different. The best organic farmers, using good husbandry and management skills, can achieve stocking rates up to 170 kg organic N/ha. In terms of paperwork, detailed records must be kept, but farmers in the Bord Bia Quality Assurance scheme and GLAS are already familiar with this type of record keeping.



**Figure 1.** Location of all organic producers in Ireland - December 2015.

## Steps to successful organic beef production

### 1. Get the information

It is important that you acquire as much information as possible before making the switch to organic farming. Prospective organic farmers should first consult with their agricultural consultant or advisor to determine suitability. This should be followed by attendance at some of the Teagasc/DAFM Organic Demonstration Farm Walks to see organic production systems at first hand, and to meet with other organic farmers, staff from the Organic Certification Bodies, the organic unit of the DAFM and Teagasc advisors/specialists. There is a wide variety of publications, advisory guidelines, research updates, videos, event/course details along with links to relevant organic bodies and organisations available on [www.teagasc.ie/organics](http://www.teagasc.ie/organics).

### 2. Assess the market

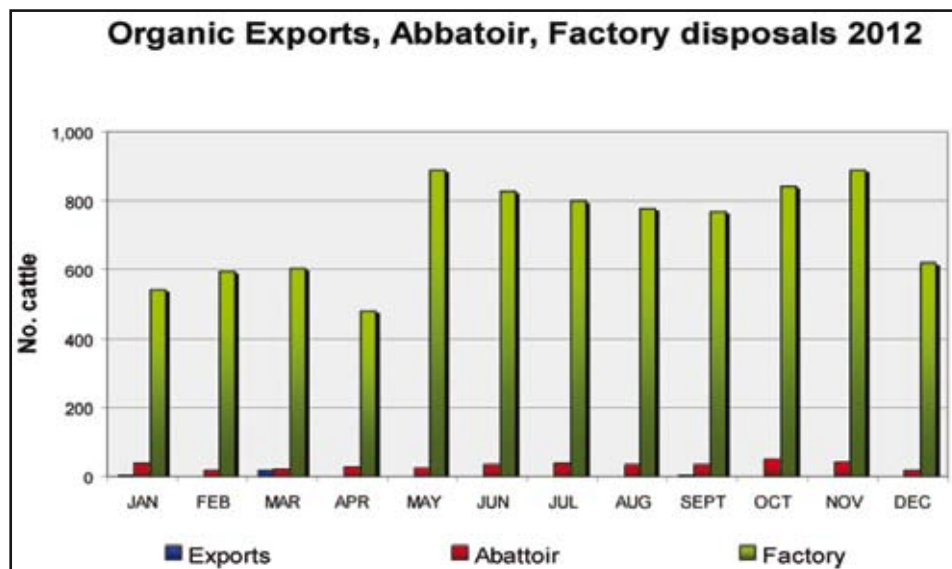
For organic farming to be profitable a premium price must be achieved for produce sold. While the majority of beef supplied to the market is from steers and heifers, recent markets have emerged for calves (organic veal) and cull cows. Beef farmers interested in organic conversion should speak with other organic farmers, processors and wholesalers about potential markets. Major factory outlets for organic beef are Goodherdsmen, Slaney Meats, ABP and Jennings. Premium prices of 15 to 20% have generally been achievable for organic beef in recent years. According to processors the demand for Irish organic beef will continue to rise, especially in mainland Europe.

### 3. Maximise payments from the Organic Farming Scheme and other supports

Consult with your agricultural consultant or advisor, or the DAFM website ([www.agriculture.gov.ie](http://www.agriculture.gov.ie)) about scheme and grant support available for organic farming. An organic farming



scheme (OFS) which is an area-based payment and both an on-farm (OCIS) and an off-farm capital investment scheme is funded under the new Rural Development Programme (2015-2020) and opens up at various stages throughout the programme.



**Figure 2.** Organic cattle disposals through factories, local abattoirs and exported live per month in 2012. Annual total = 9,000.

#### 4. Complete an organic course

A 25-hour 'Introduction to Organic Production' course has to be completed before acceptance into the DAFM Organic Farming Scheme (OFS).

#### 5. Choose an organic certification body (OCB)

In Ireland, there are three certification bodies (Demeter, IOFGA or Organic Trust) which certify organic operators involved in land-based farming under the auspices of the DAFM. The farmer initially applies to one of the three certification bodies with the application form, conversion plan and fee payable. Once the application is accepted, a conversion date is granted and a conversion period (normally 2 years) commences. The Organic Certification Body carries out an annual inspection to check compliance with the standards and to ensure that organic records are in order. Spot inspections may also be carried out to check for compliance with organic regulations.

#### 6. Complete an organic conversion plan

This involves a detailed description of management practices on the farm, the changes required on the farm, soil analysis, faecal analysis, livestock housing plan, animal health plan (in consultation with your veterinary surgeon) and land/crop rotation plan. The plan can be drawn up by the farmer alone or in consultation with the farm advisor. Attending a FETAC accredited "Introduction to organic farming course" is an excellent way of learning how to complete the conversion plan.

## 7. Provision of quality forage

To maintain farm productivity, stocking rate must be maintained as high as possible. In the absence of artificial nitrogen, white clover may be introduced into pastures to maintain grass production levels. White clover is the 'engine' that drives productivity on organic farms and can fix in excess of 100 kg N/ha annually. Red clover can fix in the region of 200 kg N/ha annually and can be a high yielding, high protein feed for wintering animals. Organic concentrates are more expensive than conventional concentrates. Prices for organic rations for ruminants are generally around €500/tonne. Maximising use of grass, using home-grown grain, purchasing grain from other organic producers and having the correct breed and system, which matches land type and market specification required, can reduce feed costs significantly. Organic straights can be purchased from a number of organic farmers for between €300 and €350 per tonne with combi-crop mixes of peas and a cereal available for between approximately €380 and €400/tonne.

Regular topping is necessary to maintain grass quality and control weeds particularly in mid-season. High quality silages can also be produced using red clover-grass swards and enough silage should be produced on-farm to meet winter feed requirements as it is not permitted to source conventionally produced silage.

## 8. Animal health

Ensuring high animal health and welfare standards is a fundamental ethos of organic principles. The farmer must be aware that the level of stockmanship required with animals is very high on organic farms. Routine treatment of animals with anthelmintics is prohibited, and a rotational grazing system should be in place to minimise worm burden. If a problem occurs, faecal analysis is recommended and the vet must sign off the appropriate treatment on the organic farmer's record book. Early detection of animal health problems is essential. Remember good animal husbandry is paramount. If an animal is suffering it must be treated and the necessary permission must be sought from the vet. The animal health plan, produced as part of the conversion plan, will deal with mineral deficiencies and vaccination issues.

## 9. Animal housing

Many farmers find that the greatest alterations that need to be made at farm level are changes to winter housing. More generous space allowances are required – for cattle the rule of thumb is that 1.0 m<sup>2</sup> is required for every 100 kg live weight. All stock must have access to a dry bedded lying area. Up to 50% of this area can be slatted but the rest must be solid floor and not slatted. Conventional straw may be used for bedding.

## 10. Nutrient recycling

Maintenance of soil fertility levels depends on the creation of a sustainable system which balances farm inputs and outputs without relying on external inputs. Good clover swards, crop rotation and targeted use of farmyard manure and slurry mean that coping without artificial fertiliser can be managed effectively. Farmyard manure needs to be put back onto grassland areas designated for grass silage production, which is rotated around the farm, and slurries needs to be applied at the most appropriate time using methods that ensure maximum recovery of the nutrients. Certain slow-releasing natural mineral sources of fertilisers are also permitted. Ground limestone is permitted as are certain commercial 'bagged' lime products provided they are approved by the organic certification body.

## Improving our understanding of cattle enterprises in Ireland

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### Summary

- There are over 100,000 farms engaged in the production of cattle in Ireland.
- Cattle production is generally combined with a range of other on- and off-farm activities.
- Eight distinctive ‘types’ of cattle enterprise are identifiable.
- Production efficiency is highest amongst farm enterprises that combine cattle production with dairy or tillage enterprises.
- The diversity of farm types involved in cattle production makes the design and delivery of supports to the sector challenging.

### Introduction

A key challenge confronting policy stakeholders and those concerned with the development of the beef sector is the highly variable nature of farm enterprises involved in cattle production. Drystock beef enterprises are characterised by substantial differences in scale, structure, degree of specialisation, intensity and combination with non-farm economic activities. As a consequence, farm operators and farm households engage with and respond to policy or development initiatives in different ways. Rather than treating the beef sector as a homogenous bloc of enterprises, it is necessary to identify distinctive sub-groups within the population of farm enterprises engaged in cattle production. This allows the demographic and economic characteristics associated with these groups to be described. Furthermore, it permits an evaluation of sources of variation in costs associated with these farm enterprises and an assessment of ways of increasing returns to each type of farm enterprise group through enhanced technical efficiency and adoption of new or novel technologies.

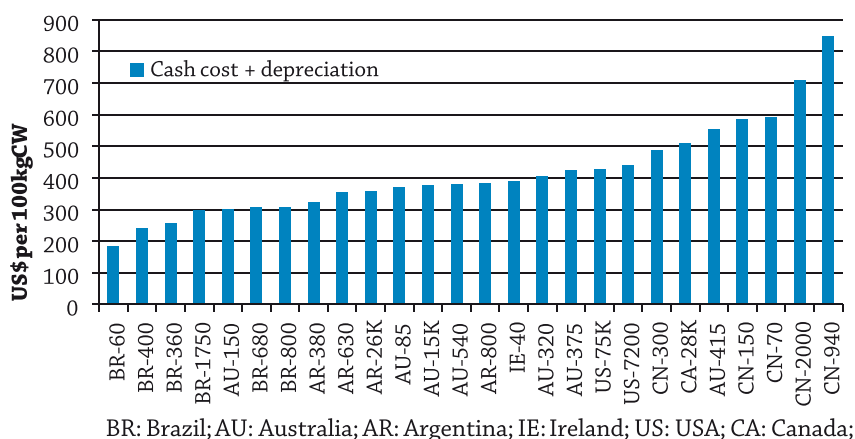
### Overview of beef production in Ireland

Cattle production remains the dominant form of farming in Ireland. The Census of Agriculture 2010 classified 55% of farms as ‘specialist beef producers’ and established that over 100,000 farm enterprises, 70% of the total number of farms, were involved in some aspect of beef production. These figures belie the fact that the returns from beef production to most farmers engaged in beef production are low, if not negative, as shown by the National Farm Survey (NFS) 2014. Given that few specialist beef producers generate a positive return from the market, it is unsurprising to find that most are dependent on CAP-related payments to off-set production losses.

Agricultural policy related to the European and Irish beef sector is increasingly based on EU external trade policy and decoupled income support payments under the Common Agricultural policy (CAP). In the two most recent reforms of the CAP (2003, 2013), member states have

had limited freedom to “recouple” some of their direct payment budgets to agricultural production. Ireland, to date, has chosen not to avail of these options. As a consequence, farm enterprises involved in cattle production have become increasingly exposed to the vagaries of the international market in recent years. In this context, the capacity of cattle producers in Ireland to compete with key international producers has become increasingly important.

In comparing the relative productivity and profitability of beef producers in Ireland with those of selected international competitors, research undertaken as part of this project has that the cash costs, e.g. fertiliser, feedstuffs, seeds and external costs such as wages, rent and interest paid, plus depreciation charges, paid by Irish beef farmers are low when compared with other important EU countries (Figure 1). This apparent competitiveness disappears, however, when total economic costs are included in the assessment. This situation is compounded by the fact that Irish cash costs (as opposed to economic costs), which are low by EU standards, are substantially higher than our main competitors worldwide. This is particularly true for suckler farms and highlights the challenges associated with further opening up the EU beef market to international producers. In turn, this highlights the critical importance of technical efficiency amongst cattle producers in Ireland. An examination of beef farms in Ireland indicates that technical efficiency in the beef sector has been consistently poor. This finding applies to the sector as a whole. Research was undertaken using NFS data to identify different types of farms producing cattle and, subsequently, identify sources of efficiency.

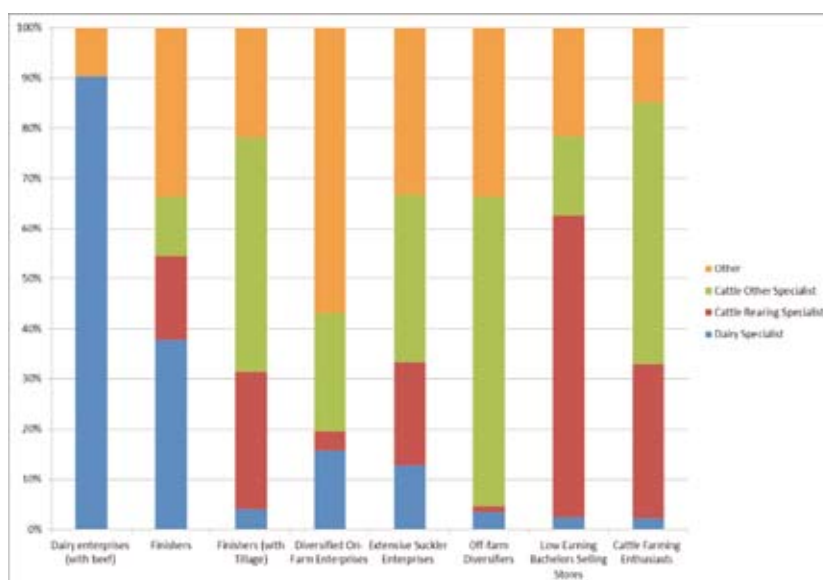


**Figure 1.** Economic costs of beef finishing production systems: Ireland v other non-EU countries (Source: Agribenchmark, 2013)

## Types of farms

The typology (classification) of cattle enterprise was created using a latent class model. The model identifies groups of farmers and enterprises by evaluating a variety of social, demographic, economic and enterprise characteristics. The model drew on data from the NFS (2012) and included all farms with any cattle (N = 821). The analysis identified eight distinct groups of farm enterprise engaged in cattle production; Dairy enterprises (with beef) (23%), Finishers (Mid-earning and Elderly) (16%), Finishers (with Tillage) (15%), Diversified On-Farm Enterprises (15%), Extensive Suckler Enterprises (12%), Off-farm Diversifiers (8%), Low-Earning Bachelors Selling Stores (7%) and Cattle Farming Enthusiasts (4%).

When compared to the NFS classification of specialist farm types we find that there is a close correspondence between enterprises classified as Dairy (with beef) and the NFS Dairy Specialist category (Figure 2). This is unsurprising and closer analysis confirms that many of these enterprises are producing calves or weanlings. We also find that a large percentage (38%) of those in the 'Finishers' category are also classified as Dairy Specialist within the NFS, whilst those working off-farm are predominantly classified as Cattle Other enterprises within the NFS. The typology of cattle production enterprises provides a more nuanced means of describing farms and farmers engaged in beef production and highlights the diversity of types of cattle production enterprises.



**Figure 2.** Comparison of NFS classification of farm enterprises with the typology of cattle production enterprises.

## Efficiency

Using this typology we compared the financial performance of the eight different classes (Table 1). The average gross output varies considerably between the classes, e.g. output from "Dairy enterprise (with beef)" is more than double that of "Extensive Suckler" enterprises. The variance in performance can be largely attributed to differences in stocking rate. This, in turn, is likely to be influenced by conditions on the farm such as soil quality and the characteristics of the farmer themselves. Perhaps the most worrying aspect of the comparison of the financial performance across the classes is the fact that only two of the eight typologies identified were, on average, making a positive market-based net margin.

## Conclusion

The results of the research present a more nuanced view of Ireland's cattle production sector. Farm enterprises producing cattle that generate a return from the market place are generally combining this activity with dairy or tillage production. These enterprises represent



the opposite ends of the supply chain; dairy enterprises are typically producing calves or weanlings, whilst tillage enterprises are finishing cattle for slaughter. Enterprises engaged in rearing cattle are, on average, making a loss and, hence, are highly dependent on CAP payments. Looking to the future it seems unlikely that the orientation of EU agricultural policy will revert to coupled direct income support measures or policy measures designed to support producer prices other than those associated with tariff protection. In this context, it will be necessary to develop initiatives that enhance the efficiency of all producers. The final stages of the project will assess the adoption of new knowledge and technology by those involved in cattle production.

**Table 1.** Average financial performance excluding premia (€ per hectare) of the eight cattle farm classes

	<b>Dairy enterprises (with beef)</b>	<b>Finishers (with tillage)</b>	<b>Finishers (midearning)</b>	<b>Diversified On-Farm Enterprises</b>
Gross output	1791	1654	1025	1012
Direct costs	1089	961	599	634
Gross margin	703	693	426	378
Fixed costs	608	635	480	459
Net margin	<b>95</b>	<b>58</b>	<b>-54</b>	<b>-81</b>
	<b>Off Farm Diversifiers</b>	<b>Extensive Suckler Enterprises</b>	<b>Cattle Farming Enthusiasts</b>	<b>Low Earners Selling Stores</b>
Gross output	979	647	958	754
Direct costs	544	409	568	508
Gross margin	434	238	390	246
Fixed costs	494	402	556	446
Net margin	<b>-60</b>	<b>-165</b>	<b>-166</b>	<b>-200</b>

## Acknowledgements

This article reflects the contributions of several authors in addition to those listed above including Maria Martinez Cillero, Thia Hennessy, Anne Kinsella, Daniel O'Callaghan and Fiona Thorne. This research is part of the Profitable Dry Stock Enterprise Development: Pathways to Growth project which was funded by the Department of Agriculture, Food and Marine through the Research Stimulus fund. The project team would like to acknowledge the input of industry stakeholders and farm operators who have contributed to the research.

## Collaborative farming options on beef farms

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### Summary

- Strong core values such as understanding, respect, trust, transparency and good communication are critical to the success of any collaborative arrangement.

#### *Registered Partnership:*

- A registered farm partnership is the ideal structure to guide beef farming families through the succession process.
- Registered Partnerships can be formed between two beef farmers by amalgamating all operations into one farm.

#### *Contract rearing:*

- An opportunity to increase output on beef farms at lower cost.
- Improved cash flow, potentially higher profit.

#### *Land Leasing/Capital Gains Tax Restructuring Relief*

- Leasing gives security of tenure to the lessee and access to income tax benefits to the landowner
- Restructuring relief is a taxation measure to help make fragmented farms become more viable through consolidation of the holdings.

## Registered Farm Partnerships

A registered farm partnership is a profit sharing arrangement between two or more farmers that is registered on the new Register of Farm Partnerships maintained by the Department of Agriculture, Food and the Marine. The new register facilitates all partnership applications from any enterprise or combination of enterprises. Firstly, in the context of the family farm, registered farm partnerships are an excellent transition arrangement that facilitates the succession process until the parents are ready to transfer over the farm entirely to a son or daughter at a later date. Secondly, in the context of non-family situations, two or more farmers can combine their respective farming operations into one single operation and they each take a share of the profits.

In a situation where a partnership has been set up between at least two active partners, the partnership model also allows for the inclusion of non-active partners who wish to make an equity contribution in the form of land or capital. This structure also facilitates situations where young trained individuals with the Level 6 agricultural qualifications enter partnership with an established farmer.

### Registered Farm Partnerships – family situations

Transferring the family farm to the next generation can be a difficult process with many questions and concerns that need to be addressed. It is often complex and therefore needs early and careful planning. A registered family partnership is the first step to consider as part

of this planning process. In many cases, parents are not in a position to transfer the farm to a son or daughter that has returned home after completing their agricultural education. There are genuine reasons for this, usually linked to concerns about the implications for family farm income and security for the parents and other family members that still have to be provided for. These concerns can be alleviated by forming a registered partnership between the parents and the son or daughter as an interim step before considering full transfer of the farm. There are social and financial advantages to forming a partnership for both the parents and the successor.

### *Taxation*

Profits are shared between the parents and successor in the partnership. Income tax incentives such as 100 per cent stock relief for young farmers can be availed of by the young farmer on their share of the profits while the parents can avail of 50% stock relief. Due to the fact that profits are shared it may also reduce the income tax paid by the family at the 20% tax band is maximised.

### *The Common Agricultural Policy (CAP)*

The current CAP has a number of measures that benefit young farmers and these schemes can be accessed by the successor through the formation of a registered partnership with their parents. They include; The Young Farmer Scheme, National Reserve and increased grant aid through the Targeted Agricultural Modernisation Scheme (TAMS II). A 50% grant is also available to help with the set up costs of forming a farm partnership. Where a successor has farmed previously in their own right, they can continue to obtain multiple benefits under the Area of Natural Constraint Scheme (ANC), Green Low-Carbon Agri-Environment Scheme (GLAS) and the organic farming scheme.

## **Registered Farm Partnership – non-family**

A partnership with another farmer(s) may offer the opportunity for increased scale, but more importantly can offer increased scale in a sustainable way. The main advantages include: increased labour efficiency leading to more flexibility for off-farm work; reduced capital expenditure by making use of existing facilities; a wider skills mix; and an improved work-life balance.

A key strength of registered partnerships is the positive impact on lifestyle. Partnerships have been shown to improve lifestyle on farms through a fair and even distribution of workload between the partners. The real reward for a good work structure is the ability to have a good lifestyle with adequate time for family and other interests. There is also greater peace of mind knowing that the other partner is carrying out the day to day operations satisfactorily, as they also have a vested interest in the efficient running of the business.

Working in partnership means there is often a better and broader range of knowledge and skills available to the partnership business. This facilitates better and more informed decision making on a wide range of subject areas. Discussions among partners mean that business decisions are teased out further and explored in greater depth. In a family situation, the partnership can provide the platform to blend the experience of the parents with the youthful enthusiasm and modern thinking of the successor.

## **Contract rearing**

Output is a key driver of profit on beef farms. Contract heifer rearing offers a lower cost way of achieving a higher stocking rate and increased output. Contract rearing is where a farmer

enters into a contract where he or she gets paid to rear breeding heifers for a suckler or dairy farmer. In setting up the agreement, it is vital to discuss and agree all the practical issues around the management of the heifers. These include: a start and end date; the number of animals to be reared; a schedule of weighing; veterinary inputs and breeding management amongst others. The enterprise can be carried out in tandem to the existing beef enterprise on the farm. Perhaps an out farm or specific area of the farm could be devoted to contract rearing. It is critical that the rearer gets paid adequately to cover direct costs and that a labour charge is included. The advantages to the rearer are that cash flow is more favourable as payment is generally paid by direct debit on a monthly basis. Another advantage to the rearer is that there is no money tied up in stock, as ownership does not transfer to the rearer. Essentially the rearing period can be broken down into five stages: calf rearing; first grazing season; first winter; second grazing season and second winter. The rearing periods need to be borne in mind when planning a rate of payment. Rearing the calves to twelve weeks of age and keeping the animals over the winter periods are the most expensive. The grazing seasons are by far the least expensive rearing periods. Each party should draw up a budget to plan and monitor their own finances. Agreement must be reached at the start on which costs are to be incurred by each party. This will determine the rate of payment per head per day.

The priority for the rearer is to cover costs and get adequately paid for his or her labour, but this comes with responsibilities. The heifers must reach their target weights at housing after the first grazing season, at mating and approaching calving after the second grazing season.

## Long-term land leasing

In recent years, strong tax incentives have been introduced to encourage long-term land leasing (at least 5 years). These measures include:

- Increased tax-free thresholds
- Confirmation that both the annual rent and the BPS entitlement value can be included.
- Limited companies can now qualify the land owner for the tax incentives.
- Removal of the 40 year age limit.
- Land may be leased for up to 25 years.

## Benefits to the land owner (lessor)

The key benefit to the lessor is that the income received from a long-term land lease and the value of any Basic Payment Entitlements is tax free subject to the limits set out in Table 1.

**Table 1.** Tax incentives for long-term land leasing

Term of lease	Maximum tax free income/year
5-7 years	€18,000
7-10 years	€22,500
10-15 years	€30,000
>15 years	€40,000

Another key benefit is that the lessor can qualify for retirement relief on capital gains tax when they transfer the land to a family member or sell on the open market. Capital gains tax is charged at 33%. This is a very valuable relief to farmers and other land owners when transferring land.

By entering into a long-term land leasing arrangement with the lessee, the landowners are providing a better incentive to the lessee to make investments in the land such as reseeding, fencing, and possibly infrastructure.

## **Benefits to lessee**

The key benefit to the lessee is that the long-term lease provides security of tenure. This allows the lessee to plan the farm business with more certainty. For example, a long-term lease may increase the size of the grazing platform, and thereby facilitate expansion of the herd. To do this on a short-term rental involves a higher level of risk as the long-term availability of the land is uncertain.

The extended term of lease allowable under the new provisions mean that the lessee can look at investment in the land in a new light. It may be easier to justify any investment carried out with a long-term lease, which can be up to 25 years.

## **Capital Gains Tax - Restructuring Relief**

The aim of the scheme is to provide relief on Capital Gains Tax (CGT) to encourage farmers with fragmented farms to consolidate their holdings and thereby improve their viability. The relief is only available on the sale and purchase of qualifying lands that meet the key criteria of the scheme.

Capital Gains Tax Restructuring Relief should be given serious consideration by farmers in parts of the country where farm fragmentation is an issue. It may involve a collaborative effort by a number of farmers to make it work in practice. Essentially, it allows parcels of land to be exchanged between farmers to reduce the number of fragmentations farmed by each farmer, and potentially increase the size of the grazing platform.

Restructuring relief operates where a parcel of land is sold by an individual farmer (or joint owners) and where another parcel of land is bought by the same farmer (or joint owners) and both of these transactions occur within 24 months of each other. The initial sale or purchase must have taken place in the period 1 January 2013 and 31 December 2016.

The combination of the sale and the purchase together must result in an overall reduction in the distance between parcels of land making up the farm, including leased parcels that have been leased for at least 2 years with a minimum of 5 years to run. The entire transaction must lead to a reduction in the fragmentation of the farm and an improvement in the operation and viability of the consolidated farm. The scheme was extended in the 2015 budget to include the disposal of an entire fragmented farm and its replacement with another farm subject to meeting the original criteria of the scheme.

## **Conclusion**

Farmers wishing to get involved in collaborative arrangements must realise that the relationship between them and the other party is the key to success. Strong core values such as understanding, respect, trust, transparency and good communication are critical to the success of the arrangement. Farmers should seek the advice of relevant professionals and consider each option carefully before choosing the one that is most appropriate to meet their farming circumstances.



# Profitable cattle farming – financial measurement and planning are key

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## Summary

- The Teagasc eProfit Monitor links together the physical (hectares of land, kg of liveweight) and the financial (income and expenses) performance of a farm.
- The reports from the system are laid out to allow you to clearly identify what is affecting financial performance.
- The information can be used to guide and influence your decision-making for the year ahead.
- Tracking farm cash flow during the year keeps you in tune with how money is used by the business and should link one year's annual eProfit Monitor with the next.

## Introduction

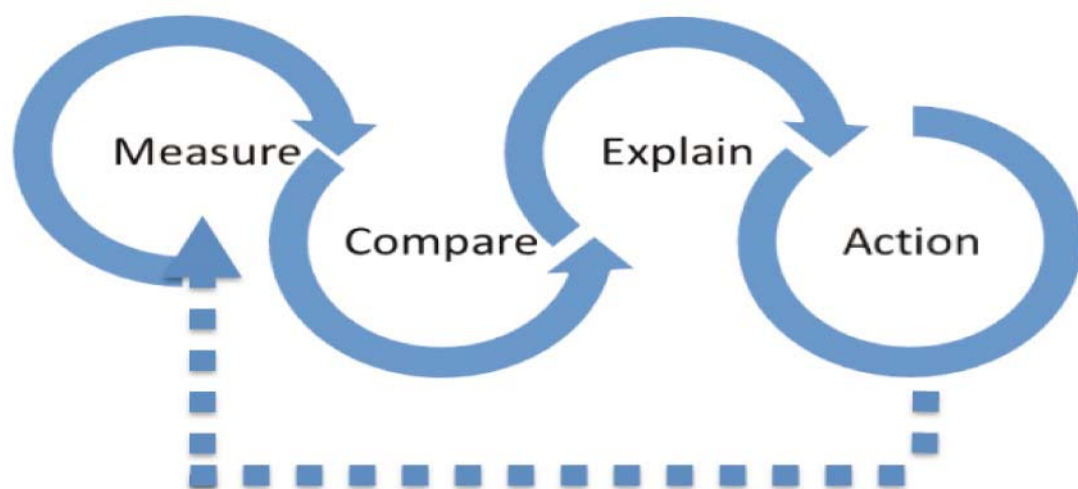
In common with many open days or farm walks, it is likely that during your visit to Teagasc Grange for Beef 2016 you will hear a lot of discussion about efficiency, output, costs of production and margin. This type of language might at first be regarded as the language of the accountant or the adviser and might seem hard to relate to your farm business. From working closely with farmers over the years, advisors are quick to point out that it is not until a farm establishes its own financial figures that these “output”, “cost” and “efficiency” terms really mean something. Those cattle farms that have used the Teagasc eProfit Monitor will be familiar with these terms and will be able to understand the importance of knowing that these financial terms often hold the key to understanding how your farm translates the practice of farming into money.

## The value in knowing your “financials”

The job of farming is a busy one with many decisions to be made, such as:

- What system to pick – steers, bulls, or heifers?
- When to buy and when to sell?
- Finishing cattle or selling as weanlings or stores?
- When to feed meals?
- When to turn out stock to pasture and when to close ground for silage?

And then there are the many small decisions that have to be made during the day-to-day running of the farm. Every one of these decisions, big and small, has an effect on the financial performance of the farm. Establishing your current farm financial performance is the first step in understanding how your farm generates profit.



**Figure 1.** Financial Measurement and Benchmarking in action on a cattle farm

## Measure - Gathering the information

The first step is to bring together all the financial information for the farm for the last year so that a few measures can be established to “take the temperature of the business”. Taking the time to pull together income and expense information to track financial progress during a distinct period of time (typically 12 months) is well worthwhile to begin to assess how the farm is performing financially. The seasonality of many cattle systems means there is often an overlap of batches of cattle on the farm and therefore assessing financial performance is seen as a difficult task but remember the information you need is often the same as that gathered together for the accountant every year. Money comes in by way of stock sales and direct payments (Basic Payments and other “premia”) and money leaves to meet stock purchase costs as well as to cover farm running costs such as feed, fertiliser and veterinary costs, among others. Teagasc have a very useful farm “cash in–cash out” recording tool called the Teagasc Cost Control Planner (CCP) which can be used on your computer to record your financial data during the year. By using the CCP throughout the year, all the farm financial information required for your full year financial analysis using the Teagasc eProfit monitor will be easily available.

### *Looking for trends in your finances*

The eProfit Monitor system takes information on the income and expenses of your business and puts them in a suitable standard layout to allow you to check how the farm performance compares from year-to-year or also how it might compare with other farms. The maximum benefit from the information can be extracted if a number of years are looked at in sequence – trends in the figures can be seen and the influence of one-off rises or falls in livestock prices or feed/ fertiliser prices can be eliminated and the underlying trends in performance observed. A key advantage of the eProfit Monitor is that it also measures some of the non-financial characteristics of the farm such as total hectares farmed, stocking rate and cattle output measured in kilogrammes of animal liveweight. The eProfit Monitor creates a link between these farm physical measures (hectares of land used/kilogrammes of liveweight produced)

with the financial measures (€ received and spent). The system breaks the financial ‘story’ of the farm year into the broad categories of gross output, variable costs, gross margin, fixed costs and profit. The results that come back from the eProfit Monitor provide a picture of what happened in financial terms on your farm in the last year – what was sold, how much did it cost to get it to sale and what it cost in overall terms to run the farm for the last year. This is more than just good information to know – an awareness of your costs of production is vital in a business where profit margins are often tight. The knowledge of what your farms’ costs are when expressed per kg of output or per hectare will help you make decisions around:

- What production system is most profitable for your farm?
- Where you buy in stock it can help you set your maximum purchase price so that you can generate a margin when the time comes to sell?
- At what input purchase price does it make economic sense to utilise high-cost inputs, such as concentrates, to help you bring stock to the point of sale?

## Compare – Benchmarking in action

However, just measuring the financial performance of your farm is usually not enough to give you the answers to the questions above. The next step is to compare (benchmark) your farm financial and physical measures against another set of measures to help you identify areas of difference, which you can then examine further. The first comparison is often with your own farm figures from the previous year – that’s if you have completed an eProfit Monitor for at least two years. This can tell you a lot – and it can help tune you in to how the figures in the eProfit Monitor reports relate to the years’ events on your farm – events such as the number and type of stock sold, the regular spending on inputs as well as the exceptional spending on items like building investment and reseedling. Our experience in Teagasc is that only by completing an eProfit Monitor consistently over a number of years can you get a real “feel” for the farm financial pedigree.

For example:

- How does the farm generate cash?
- What are the main areas where money is spent?
- Are there areas where spending is increasing?
- Is this in line with spending in other farms?

## Explain – Linking the financial to the physical

Once you have a reasonable understanding of the farm’s financial progress during the year and you can link it back to the actual physical sales of stock and usage of inputs, then you are in a position to begin to compare the farm against other farms operating similar production systems on similar land types. Those farmers that are members of discussion groups where the eProfit Monitor information is shared can look at performance of other group members and gauge their own farm performance against them. This is very useful, especially if you can tease out what these other farms are doing differently that results in them achieving better financial results. If you are not a member of a discussion group then you can also get some guidance from the national annual summary Drystock eProfit Monitor analysis produced by Teagasc and available on [www.teagasc.ie](http://www.teagasc.ie)

## Action – Targeting areas for improvement

Once you have teased out what makes your business tick financially then you should start to think about putting a plan in place to improve the areas you have identified that are holding back your farm profitability. Your advisor can be of considerable assistance here in helping you to:

- Identify key areas for improvement.
- Set targets for what your financial performance SHOULD be and put a timescale on achieving these targets.
- Specify the actions needed to achieve these targets with an emphasis on key day-to-day farm management decisions that you need to follow.

To keep you on track during the year you can again use the Teagasc Cost Control Planner. By converting your targets into actual monthly “cash in-cash out” targets you can set up a cash flow budget to track cash income and spending during the year. As you record your income and expenses during the year you can check to see if the actions you are taking to improve the profitability of the farm are having the effect you hoped for. The final step at the year-end is to complete *another* eProfit Monitor and check by benchmarking against the previous year if you have made financial progress.

If you want to avail of the Teagasc eProfit Monitor service or get a copy of the Teagasc Cost Control Planner then contact your local Teagasc advisory office or contact us by email on [profit.monitor@teagasc.ie](mailto:profit.monitor@teagasc.ie)

Completing a Teagasc eProfit Monitor will help to:

- ▶ Establish current levels of performance both physical and financial.
- ▶ Benchmark own performance against others with similar systems.
- ▶ Monitor progress on your farm over time.
- ▶ Identify areas of weakness that need improvement.
- ▶ Guide in setting realistic targets aimed at improving future profitability.





# **Technology Village:**

## **Breeding – Fertility and Reproduction**

## Feeding the suckler cow for optimal reproductive efficiency

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### Summary

- The length of the interval from calving to resumption of heat cycles is heavily influenced by the nutritional management of the cow prior to calving.
- Body condition scoring should be used to inform nutritional management.
- Target body condition scores (BCS) can be used to optimize cow fertility and cost-effectively manage winter feed requirements.
- Target BCS (scale 0-5) at the key stages of the production cycle, namely weaning, calving and breeding for a spring-calving cow are 3.0+, 2.5 and 2.5+, respectively.
- Cows thin at calving (BCS <2) have delayed resumption of heat cycles, resulting in a delay in the interval from calving to re-breeding.
- Cows and heifers should be maintained on a steady plane of nutrition during the breeding season

### Introduction

Annual calf output is the single most important parameter in measuring production efficiency of suckler cow herds. However, nationally, on average, suckler cows are producing only 0.80 calves per cow per year with typical calving intervals approximately six weeks beyond target. In order to improve reproductive efficiency, the two main factors farmers must focus on are: (i) the interval from calving to first heat (postpartum interval), and (ii) subsequent conception rate. Additionally, nutrition of the cow is the greatest expense in suckler beef production systems. As such, in order to improve the profitability of suckling systems, feed costs need to be minimised, especially during the indoor winter period, where as much as 55-65% of the cows' feed costs (€420 to €450/ cow) are incurred. Therefore, appropriate nutritional management of the herd, its affect on postpartum interval (PPI), understanding cow feed requirements and cost-effective management of cow body condition score (BCS) at key points during the reproductive cycle will be the focus of this chapter henceforth.

### Postpartum interval

The interval from calving until the re-initiation of oestrous cycles, often referred to as postpartum interval, has long been recognized as the primary factor impacting upon the reproductive efficiency of suckler cow herds. Although the duration of this interval averages about 60-70 days for suckler cows and is about 15-20 days longer in first-calving heifers, it can vary hugely between animals, ranging from 30 to 180 days. For seasonally calving suckler cow herds to maintain a 365 day calving interval, the aim must be to achieve conception within 75-80 days (i.e. within one to two breedings for most cows) of calving. Teagasc data

show that for each day that the calving interval extends beyond the target of 365 days, it costs the herd owner in the region of €2 per cow per day, mainly in feed costs.

The length of the PPI is governed by many factors but is primarily influenced by (i) maternal off-spring bond that exists between the cow and her calf and (ii) nutritional status of the cow (primarily pre-calving nutrition). While management of the former, requiring temporary restricted suckling (see page 38), may not be practical in herds calving close to turnout, management of the latter is eminently achievable in all herds.

## Body condition scoring

Cow body condition scoring (estimate of degree of fat reserves) is a practical management tool that farmers can use to monitor the nutritional status of their cows. A series of target condition scores can be used to manage the cow's feed requirement, thereby ensuring that cows are in the correct condition at the key stages of the production cycle, namely weaning, calving and particularly, breeding.

Ideally, a spring-calving cow should be housed at the end of the grazing season at a BCS of 3 to 3.5 (scale 0-5). Over the winter period, the cow can utilise some of her body reserves (0.5 to 1.0 BCS units) in order to calve at a BCS of 2.5. Post-calving, a further but limited amount of body condition (0.25 units) may be mobilised from calving until turnout to pasture. Ultimately, the goal is for the cow to gain body condition (i.e. positive energy balance) in the period leading up to mating, such that at breeding the minimum BCS is 2.25, and ideally 2.5 (during the grazing season, cows can readily gain 1 BCS unit, equivalent to 75 to 100 kg bodyweight). Thus, the manipulation of the cows' fat reserves between winter and summer is an important strategy in controlling feed costs.

For cost-effective feed management, the target is to economically build up body reserves from lower cost grazed grass and utilise these reserves over the indoor winter period when feed costs are highest. Successfully managing this feeding strategy is central to profitability on suckler farms as it can dilute the cost associated with keeping a productive cow, whilst at the same time maintaining reproductive performance. For example, maintaining suckler cows at optimum BCS can lead to a winter feed saving equivalent to 1.0 to 1.5 tonnes fresh weight of grass silage. In simple monetary terms this is equivalent to a €30 to €35 saving per cow translating to a yearly saving to the enterprise in the region of €1,500, for a herd of 50 cows. In brief, charting body condition score can be used to plan feeding management through the year so that optimum cow reproductive performance is achieved, at minimum feed cost.

## Feeding the pregnant suckler cow

### *Group at target BCS (3.0-3.5)*

Suckler cows in moderate to good BCS (~3.0+) at housing can be restricted to 75% of feed requirements in order to reduce winter feed costs. Dietary (energy) restriction can be evoked through various approaches including offering moderate-quality grass silage (65-68% Dry Matter Digestibility, DMD) *ad-libitum* and where silage quality is good, reducing the quantity offered or diluting its energy value by adding straw to the diet. It is important to ensure an appropriate pre-calving mineral supplement is offered to all cows for a minimum of 6 weeks pre-calving, that feeding rate is accurate and that free access is not impeded.

### *Thin/undernourished group (BCS <2.5)*

Thin cows (and first-calved heifers) are priority animals and require special attention. Cows thin at calving will be at least two to three weeks slower to resume normal heat cycles

compared to those in moderate to good BCS. Such cows face a challenge of a delayed return to cyclicity which, without appropriate intervention, has serious implications for achieving a 365-day calving interval. Once identified, thin pregnant cows must be fed in excess of their requirements until target BCS is met if optimal reproductive performance post-calving is to be achieved. This priority group should receive *ad libitum* access to high-quality silage (>70% DMD) and once target BCS is met (BCS 2.5), such cows can be re-integrated with the main herd. Alternatively, if only moderate-quality silage (65-68% DMD) is available, supplementation with 2-3 kg of concentrate per day will be necessary to meet the cow's nutrient requirements. Typically, over a three month period, thin suckler cows fed to their requirements should be gaining 0.7 kg/day, equating to 70 kg of bodyweight or 0.75 of a condition score.

To avoid nutritionally-induced difficult calvings, it is important to note that changes in BCS/bodyweight needs to take place prior to the last two months of pregnancy, as dietary energy at this time is primarily partitioned towards foetal growth. Indeed, prevailing diet during this period has important implications for calving ease, colostrum quantity and quality and potentially subsequent calf viability.

## **Nutritional requirements of the calved (lactating) suckler cow**

While pre-calving nutrition, through its effects on the fat reserves of the cow, has a much greater influence on the resumption of normal heat cycles than post-calving nutrition, nonetheless, it is important that the cow is fed to meet the energy requirements of lactation and moderate body fat accretion. For example, compared to a dry cow, the lactating suckler cow rearing one calf can require up to and greater than 50% more feed (energy) if requirements are to be met. Specific requirements for individual cows will be dependent on factors such as breed type or level of milk production, body weight, age and calving date.

### *Early-calving: January to early-February*

In many herds, for cows calving in January and early February the breeding season will commence while cows are still indoors. To ensure good reproductive performance, such cows must be fed to their requirements and cannot tolerate any prolonged feed energy deficit pre-breeding. Cows should receive *ad libitum* access to moderate-to-high quality grass silage supplemented with concentrates at a rate of 1.5-2.5 kg per day (depending on silage quality and milk yield potential) until turnout to pasture. On farms where silage quality is poor (e.g. <65% DMD) an additional 1-2 kg of concentrate per cow will be required to meet the cows' requirements. An appropriate mineral/vitamin mix should always be offered, while cows are indoors.

### *Calving mid-February to late-March*

For these animals, calving date is more closely matched to the onset of the grazing season. When offered moderate quality grass silage (65%-68% DMD) *ad libitum* a suckler cow (650 kg to 700 kg) producing between five and ten litres of milk will have a feed energy deficit. However, if in appropriate condition at calving (BCS >2.5), cows can be allowed to mobilise some body fat reserves for the four to six week period after calving to make up for this energy shortfall. This generally equates to a BCS loss of approximately 0.25 units, which is acceptable over a limited timeframe, provided that the cow is offered sufficient quantities of high quality grass following turnout to pasture.

### *Priority animals (first-calving heifers and thin cows)*

Regardless of breed type, preferential feeding of cows calving for the first time and cows

in poor body condition ( $BCS \leq 2$ ) will be required. Such cows face a challenge of a delayed return to normal cyclicity which, without appropriate intervention will severely impact upon the length of their subsequent calving interval. It is recommended, in all cases, that these priority animals receive some concentrate supplementation after calving, until turnout to grass. Where silage quality is moderate-to-good, feed 1-2 kg of concentrate, and where silage quality is poor, feed 2-3 kg of concentrate, daily.

## Nutritional management during the breeding season

While pre-partum nutrition plays a key role in regulating the PPI, mainly through its modulating effects on BCS, both concurrent plane of nutrition as well as the chemical composition of the diet during the breeding season, has been shown to affect conception and pregnancy rates. At grass, in order to maximise pregnancy rates, the cows and heifers must be offered a steady supply of high quality pasture. Ideally, swards should have a pre-grazing herbage mass of 1,400 kg/DM/ha equivalent to a herbage height of 10 to 12 cm. Fluctuations in feed supply especially in the first two weeks after breeding should be avoided. Indeed, Teagasc data shows that beef heifers maintained on a high plane of nutrition at pasture prior to breeding and subsequently switched to a low daily pasture allocation directly after breeding suffered a 50% reduction in conception rate compared to their contemporaries maintained on a steady plane of nutrition throughout.

In general, the protein requirements of beef cows for maintenance, milk production and reproduction can be readily met from good quality grass alone and thus, protein deficiencies should not occur. Some researchers have raised concern in the past over possible deleterious effects of high protein diets on reproductive efficiency of dairy cows and heifers in particular. While beef cows or heifers are generally not exposed to excessively high dietary levels of protein, it has been suggested in the past, that cows grazing lush pasture with a high nitrogen fertiliser input may be at risk of lower pregnancy rates. In order to examine the effect of dietary protein intake on reproductive performance, a series of experiments were conducted by Teagasc using beef heifers offered either high or low protein diets both indoors and at pasture. Despite raising dietary protein levels well in excess of those previously reported to be associated with reduced fertility, no effect of diet was observed on any measure of fertility, including pregnancy rate,. It is unlikely, therefore, that the range in protein intake typically experienced by beef cows and heifers managed under grass based production systems will appreciably affect reproductive efficiency.





## Maximizing the use of artificial insemination in suckler herds

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### Summary

- Current usage of artificial insemination (AI) is low in Irish suckler herds and this has implications for the speed of genetic improvement.
- Beef farmers need a specific breeding programme to produce quality herd replacements, particularly within the context of the Beef Data and Genomics Programme (BDGP).
- AI should particularly be targeted at the beginning of the breeding season when heat detection is easiest.
- A timed AI programme should be considered where labour requirements of heat detection are impractical.

### Introduction

In Ireland, approximately 20% of calves in beef herds are bred from artificial insemination (AI). Such low usage of this well-tested and effective technology most likely reflects the difficulty and labour requirements for heat detection, assembly of cow(s) for insemination, as well as land fragmentation in beef herds. Despite this, it is well acknowledged that AI allows access to genetically proven sires for terminal, maternal and ease of calving traits thus, facilitating greater genetic progress and ease of management. Additionally, semen used in AI is consistently monitored for fertility and is generally of very high quality and collected from bulls tested clear of transmissible diseases. With natural service bulls, although the reported incidence of sterility is generally low (<4%), subfertility, at a consistent level of 20-25%, is a much more common issue. Furthermore, use of AI can obviate the necessity to maintain a bull(s) on the farm, and/or can reduce the number of bulls required, which is always a potential farm safety hazard.

Many beef herds have no defined policy for producing quality female replacements, with the result that many herds have become almost pure-bred with a consequent loss of hybrid vigour. This can lead to a decline in cow fertility and calf vitality and survival as well as a decline in cow milk production and calf performance. The importance of quality replacement heifers in beef herds is becoming increasingly recognised. One of the primary objectives of the current Beef Data and Genomics Programme (BDGP) is to improve the genetic merit of the national beef herd with regard to maternal traits. In order to meet the requirements of the programme and given the typical small size of Irish beef cow herds, it is envisaged that AI will be increasingly used to produce higher genetic merit (4 and 5 star on the Replacement Index) female replacements.

## Breeding and the establishment of pregnancy

Once oestrous (heat) cycles have commenced it is the combined effect of heat detection efficiency (submission rate) and conception rate that determines pregnancy rates and ultimately the compactness of calving after a short defined breeding period. Where AI is used, the better the heat detection rate and the prevailing herd fertility, the more cows that will be pregnant at the end of the breeding season.

Where an active, fertile bull(s) is used, it is expected that all cows and heifers in heat should be mated and, therefore, under such circumstances, compactness of calving and pregnancy rate will be solely the function of bull fertility. For herds using AI, accurate detection of heat is of paramount importance to achieving good success.

Indeed the time, effort and skill involved in heat detection is usually the downfall of successful AI usage in many beef cow herds. It is suggested that about 10% of the reasons for failure to detect heats are attributable to “cow” problems and 90% to “management” problems. The latter includes too few observations per day for checking for heat activity; too little time spent observing the cows or observing the cows at the wrong times such as at feeding time or movement to a new paddock. A major reason for failure to detect heat is a lack of adequate knowledge of the signs of heat. To optimise heat detection both the primary (standing to be mounted) and secondary signs, must be clearly understood. Notwithstanding this, however, the widely accepted laborious, repetitive nature of heat detection has focused interest on the use of technologies to improve detection rates and/or reduce the labour and commitment involved in observation.

## Oestrous synchronisation for beef cows

Measures to control the oestrous cycle, or synchronised breeding regimens have been commercially available for more than 25 years. In recent years a number of alterations have been made to previously used protocols and some new protocols have been developed. The following section will give a brief overview of recently developed regimens for use in beef cows and replacement heifers.

### *Practical requirements of an oestrous synchronisation regimen*

- High proportion of cows must ovulate in a timely manner to allow timed AI (TAI).
- Be capable of inducing heat and normal fertility in cows that have not yet resumed cyclicity after calving (i.e. anoestrus).
- Require a maximum of three assemblies.
- Be cost effective.

At the start of the breeding season, typically up to 50% or more of beef cows, calved 40 days or more will not have ovulated or resumed normal heat cycles. Thus, any oestrous synchronisation programme used must be effective in both cyclic and non-cyclic cows alike. This requires programmes to be based around the use of a device that releases the hormone progesterone, (i.e. a PRID or CIDR) if an acceptable pregnancy rate is to be attained.

### *Recent Teagasc studies on timed AI in beef cows*

Because of the issues around labour involved in heat detection, land fragmentation and the part-time nature of most beef cow herds, there has been increasing interest in the use of oestrous synchronisation protocols which facilitate the use of TAI, where all treated cows are inseminated at a pre-determined time, regardless of whether signs of heat were observed or not.

In order to obtain accurate and robust information on the potential for TAI in Irish beef cow herds as well as to compare currently available protocols, Teagasc, together with UCD and the Agri-Food and Biosciences Institute of Northern Ireland (AFBINI) recently conducted a series of large-scale, DAFM funded, on-farm synchronisation studies involving 85 beef cow herds over the island of Ireland. The trials were run in both autumn- and spring-calving herds with 2200 cows, calved  $\geq 35$  days, enrolled across the spring and autumn of 2014 and spring of 2015. Three different synchronisation protocols were compared, which included the protocol outlined in Table 1 as well as two minor variations of this. All cows were subjected to a single TAI at 72 hours after PRID E (CEVA Animal Health) removal. The average size of participating herds was 27 cows. Additionally, as herdowners were free to use the semen of their choice (all herds used a commercial AI service), a large number of AI sires were used across the studies. Pregnancy rates ranged from 50-70% in these trials, with a very acceptable overall average pregnancy rate of 55% achieved to a single timed insemination.

**Table 1.** Recommended synchronisation regimen for beef cows  $\geq 35$  days calved

Day	Action
Day 0, am (Monday)	PRID or CIDR insertion + GnRH at insertion.
Day 7, am, (Monday)	PRID or CIDR removal + prostaglandin + 400 iu eCG (also known as PMSG) i.m. at time of removal (Ideally tail paint cows or affix heat detection patches to cows).
Day 8 (Tuesday)	Cows will start to show standing heats late pm and through the night. Record cows in heat and active.
Days 9 and 10 (Wednesday-Thursday)	Most heats expected on Day 9. For best results, inseminate all cows 12 hours after initial observed standing heat. Cows not observed in heat can be inseminated at 72 hours following PRID/CIDR removal (i.e. Thursday am, here) but must receive GnRH at AI. If heat detection is not possible, all treated cows can be inseminated once at 72 hours after PRID/CIDR removal (or as close as possible to this time), though GnRH must be administered to <b>all cows</b> coincident with AI.

**Notes:** 1. All drugs are Prescription Only Medicines (POMs) and are under veterinary control. 2. Dosage of drugs: will vary according to drug and drug formulation.

More importantly, synchronisation had the effect of condensing the calving pattern and the subsequent breeding period the following season. For example, 78% of all synchronised cows were pregnant within 23 days of the start of the breeding season (55% to TAI plus 48% of repeats to the first cycle after TAI). While many herds decided to AI cows that repeated, others turned out stock bulls approximately 10 days after the TAI. This latter practice is very popular in large herds throughout north and south America, as together with removing the necessity to detect heat in repeats, it also reduces the cow-to-bull ratio, with many herds focussing on the use of maternal genetics for the TAI and on terminal traits in their stock bulls.

### *Success with synchronisation treatments*

As alluded to above, cows that fail to become pregnant to the synchronised breeding and that

repeat and are re-inseminated usually have normal fertility at the repeat heat. For best results with oestrous synchronisation in beef cows, it is recommended that:

- ▶ Cows are in a moderate BCS score (2.5–3.0) at time of treatment. It is equally important that cows are a minimum of 35 days calved at the start of the programme and are have a continuous supply of high quality pasture available on a for a minimum of 3-4 weeks prior to, during and after treatment.
- ▶ Synchronization should only be used in herds where the levels of management and in particular heat detection skills are high in order to detect heats and particularly repeat heats. Alternatively, a bull should be turned out with cows 7-10 days following the initial AI.
- ▶ It is vitally important that high fertility semen is used and the competence of the inseminator is high. Semen must be thawed carefully (15 seconds in water at 35°C) and the cow inseminated within 1-2 minutes of thawing. The correct site for semen deposition is in the common body of the uterus. Each straw should be thawed separately.

## Synchronisation regimens for replacement heifers

Where the vast majority of replacement heifers are cyclic during the breeding season there is a reduced requirement for incorporating an exogenous source of progesterone in the synchronisation regimen. Consequently, prostaglandin-based regimens are the methods of choice for use on post-pubertal, cyclic replacement heifers. A common regimen used for heifers involves two administrations of prostaglandin (PG) at an 11-day interval. All heifers can be inseminated twice on a fixed-time basis at 72 and 96 hours after the second administration without any heat detection or, alternatively, heifers can be checked for heat after the 2nd prostaglandin administration and inseminated on the basis of a detected heat. A more cost-effective regimen involves good heat detection carried out for the initial 6 days, during which all heifers detected in heat are inseminated. On the 6th day all heifers not yet detected in heat are injected with prostaglandin. About 90% of the injected heifers will respond to the prostaglandin and show heat 2-4 days after injection and should be inseminated as normal. Using this protocol, drug use, semen costs and veterinary costs are minimised. Conception rates to prostaglandin-induced heats are normal (65-75%). It is imperative that heifers are bred to easy-calving sires, as dystocia or calving difficulty can be four-fold higher in heifers than in more mature cows.

## Sexed semen

It is expected that sexed semen will become more widely available in the next number of years. Currently, conception rates are 10-15 percentage points below those achieved with conventional frozen thawed semen. Current recommendations are that sexed semen should only be used in replacement heifers which are normally highly fertile (expected conception rates of 65-75% to a single service using frozen thawed conventional semen). Even at a conception rate of 50%, the use of sexed semen to produce high genetic merit female replacements may be worthwhile provided the premium on the sexed semen is not excessive.

## Acknowledgements

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## Current research on the role of infectious diseases and trace elements in the fertility of beef cow herds

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### Summary

- To achieve a 365-day calving interval, the cow must become pregnant again within 85 days of calving.
- Various infectious diseases and trace elements have often been implicated in poor reproductive performance, though there is little information to substantiate this for beef cow herds.
- The impact of infectious disease and trace element status on herd fertility is currently being examined as part of a large All-Ireland beef cow fertility research programme led by Teagasc.
- Farmers should complete a herd health plan with their veterinarian to identify, control and monitor pathogen and mineral status on the farm.
- Where vaccination and mineral supplementation programmes are implemented the manufacturer's instructions should be followed carefully.

### Introduction

Improving reproductive efficiency will be one of the key factors in achieving the productive and economic targets set out for the beef industry in Food Wise 2025. The target calving interval for a suckler herd is 365 days. To achieve this, cows must become pregnant again within 85 days of calving. However, the average calving interval for Irish suckler herds in 2015 was 407 days, with only 8 in every 10 beef cows producing a calf every 12 months (ICBF, 2015). While there are many potential reasons for poor fertility in beef cow herds, the relative importance and potential impact of the various contributory factors and in particular, infectious disease and trace mineral status, have never been quantified.

### Impact of pathogens and trace minerals on reproductive performance

In recent years, the issue of herd health and in particular infectious diseases has received increasing prominence as a factor influencing reproductive efficiency in beef cows. Numerous bacterial, viral and protozoan pathogens have been associated with poor reproductive performance and abortion in cattle. These diseases can have a significant impact on the cow's ability to produce a viable healthy calf and can result in abortions, stillbirths, or the birth of weak calves.



*Leptospirosis* is a bacterial (zoonotic) disease that is characterised by reproductive failure, including abortion, stillbirths and birth of weak offspring. In cattle, hardjo-bovis and -prajitno genotypes (i.e. sub-serovars) are responsible for host-adapted persistent infections. These serovars cause insidious reproductive losses throughout gestation. Leptospirosis is transmitted through direct contact with urine, milk or placental fluids and the bacteria are stored in the kidneys of infected animals. Previous research in Ireland showed that greater than 80% of Irish beef cow herds were deemed 'infected' with leptospirosis.

*Bovine Viral Diarrhoea Virus (BVDV)* is a pestivirus endemic in cattle populations. There are two forms of infection: persistently infected (PI) or transiently infected (TI). Animals only become a PI when exposed to the virus during pregnancy (2 to 4 months), while animals become a TI when infected after birth. BVDV can affect female fertility through a wide range of clinical conditions such as foetal resorption, abortion, mummification and birth of immune-tolerant persistently infected (PI) calves. Previous Irish research suggests a herd prevalence of > 95 % in both beef and dairy herds in Ireland.

*Infectious Bovine Rhinotracheitis (IBR)* (also known as Bovine herpes virus 1 (BHV-1)) is a highly contagious respiratory disease and primarily affects the upper respiratory tract and can affect all age groups of cattle in the herd. Symptoms of the disease include dullness, reduced appetite, nasal discharge, pneumonia, abortions and poor fertility. Two previous Irish studies conducted on beef and dairy herds both reported herd level seroprevalence of BHV-1 to be approximately 75%.

*Neosporosis* is caused by *Neospora canium* which is a coccidian parasite. Dogs and foxes are the definitive host of the pathogen. The parasite can be spread vertically from the cow to the foetus during pregnancy, or horizontally through contamination of feed from faeces of infected dogs. Infected cows are more likely to abort compared to their non-infected counterparts with abortions occurring at any stage of gestation. To-date, there is no published information on the seroprevalence of neosporosis in Irish cattle herds.

*Trace minerals:* Trace minerals (particularly copper, iodine and selenium) are essential components of many biochemical pathways, enzymes and hormone systems necessary to support normal growth, reproduction and lactation. Deficiencies in the macro and micro elements can lead to a number of economically important conditions including hypocalcaemia (milk fever), mastitis, lameness and retained afterbirth. Deficiencies of trace minerals, in particular, have been implicated as a cause of poor reproductive performance in cattle in Ireland, though there is a lack of scientific evidence to substantiate this. Indeed, herd-owners in Ireland and elsewhere frequently undertake expensive supplementation strategies, often with little evidence of a benefit to herd health productive or reproductive performance.

## **'BeefCow' Research Programme**

A large Department of Agriculture, Food and Marine (DAFM) funded all-Ireland beef cow fertility research programme, led by Teagasc Grange and involving University College Dublin, ICBE, Agri-Food and Biosciences Institute in Northern Ireland and the Irish Farmers Journal, is currently examining a range of factors affecting the fertility of beef heifers and cows. One of the main elements of this research programme is to conduct a comprehensive epidemiological study of the key factors affecting reproductive efficiency of commercial beef cow herds, with

particular emphasis on the prevalence and impact of pathogen and trace element status. Specifically, the objectives of the study are to determine: (i) the sero-prevalence of the aforementioned pathogens in beef cow herds; (ii) trace element (copper, iodine and selenium) status of herds during the breeding season; and, (iii) the relationship between the pathogens and trace elements of interest, with herd reproductive efficiency.

Thus, almost 6,000 cows from 169 spring calving suckler cow herds (Table 1) across the island of Ireland (32 counties) were blood sampled during the summers of 2014 and 2015 in order to establish pathogen and trace element status. A comprehensive survey was also carried out to determine the vaccination policy undertaken in each individual herd.

**Table 1.** Breakdown of participating herds in the Republic of Ireland (ROI) and Northern Ireland (NI)

Herd Type	No. of Herds	No. of Cows
Teagasc/IFJ BETTER Beef herds (ROI)	17	984
Northern Ireland Suckler Beef Programme herds (NI)	8	349
Research herds (ROI & NI)	5	392
Commercial (sign-up) herds (ROI & NI)	139	4212
<b>Total:</b>	<b>169</b>	<b>5937</b>

Preliminary findings from the study indicate a sero prevalence of 71%, 78%, 44% and 5% for leptospirosis, BVDV, IBR and neosporosis, respectively; in non-vaccinating beef cow herds. Additionally, results to date suggest that many cows (Table 2) are deficient in selenium, iodine and copper, reflecting low soil and herbage concentrations of these trace elements on many farms (Table 3), though similar to the situation with pathogen exposure, considerable variation was observed between herds. Final results from this research project, including an analysis of the relationship, if any, between cow fertility and the aforementioned pathogens and trace elements, will be available later in 2016.

**Table 2.** Mean blood (plasma) concentrations of trace elements (copper, iodine and selenium) in Irish beef cows during the breeding seasons of 2014 and 2015 with published recommended lower and upper limits for blood concentrations in cattle.

Trace element	Mean	Range (across herds)	Lower and Upper limit	% cows below Lower limit
Copper ( $\mu\text{M}$ )	11.91	0.48 – 38.00	8.78 – 20.40	15%
Iodine ( $\mu\text{g/L}$ )	30.37	3 – >150	51 – 300	82%
Selenium ( $\mu\text{M}$ )	0.52	0.01 – 3.70	0.91 – 1.52	79%

**Table 3.** Mean concentrations of trace elements (mg/kg/DM) in soil and herbage on Irish beef cow herds during the breeding seasons of 2014 and 2015.

Trace mineral	Copper (mg/kg/DM)	Molybdenum (mg/kg/DM)	Selenium (mg/kg/DM)	Iodine (mg/kg/DM)
Soil	18.25	0.74	1.04	3.09
Herbage	6.67	2.46	0.38	0.28

## Bioeconomic herd fertility management model

A whole-farm bioeconomic model is being developed to provide information on the economic impact of a range of factors deemed to affect reproductive performance for Irish suckler beef cow systems. The key focus of the model will be on the economic implications of: (i) breed and nutritional factors affecting age at first calving (drawing on the findings of an on-going large beef heifer puberty experiment at Grange); (ii) the impact of alternative oestrous synchronisation interventions on reproductive outcomes for beef cows (utilising findings from recent large scale on-farm studies); and (iii) the prevalence of reproductively important pathogens and trace minerals (as described above). The model and its derivatives will be available as a management tool to aid farmers and other industry professionals to evaluate alternative reproductive strategies and interventions for spring calving beef cow herds. The findings will also inform the on-going development of genetic indices for beef cattle in Ireland.

## Implications of this research for Irish suckler farmers

The findings of this research will contribute towards a more comprehensive understanding of the implications of pathogen and trace element status on the reproductive and productive performance of beef cow herds. Furthermore, genetic analysis will be carried to determine the heritability of disease trace element status, the results of which could be incorporated into future breeding programmes. Additionally, the outcomes will aid herd owners and veterinarians in terms of understanding and implementing the three pillars of herd health management, with particular emphasis on optimising reproductive efficiency.

1. *Identification:* Blood sample a proportion of the herd to determine pathogen and trace element status before the breeding season commences. Soil measurements for trace element status should be taken to a depth of 10 cm from the grazing area. Grass samples are taken to a minimum height of 3.5-4.0 cm. Keep up-to-date records of all herd health and vaccination events.
2. *Control:* Bioexclusion, culling and vaccination are the three options available to control disease spread. Targeted supplementation can be used to address particular deficiencies in trace minerals in the herd. It is important that herdowners follow the manufacturers' instructions carefully to ensure that vaccines and mineral supplements are administered in the correct dosage and frequency.
3. *Implementation/Monitoring:* Implementation and continuous monitoring of the herd health plan is important to determine if intervention approaches such as vaccination/mineral supplementation are effective. Seek veterinary advice on creating a herd health plan tailored for your herd. A well-implemented herd health plan has the potential to prevent an outbreak of disease(s) in the herd whilst also minimizing the not insignificant veterinary costs associated with clinical disease.

## Acknowledgements

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## The Maternal Herd

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### Summary

- The *Maternal Herd* was established at Grange to validate the Euro-star Replacement Index and determine the effectiveness of the index to select animals suitable for breeding heifer replacements.
- Results to date show that, with the exception of cow body weight, body condition score (BCS) and milk yield, the animals' Replacement Index value has had no influence on production performance; however, traits included in the index such as carcass performance of the progeny and cow survival have not been evaluated to date.
- The study is set to continue for a further two years to collect additional information on the effects of cow Replacement Index on key traits such as lifetime production efficiency, reproductive performance and survival.

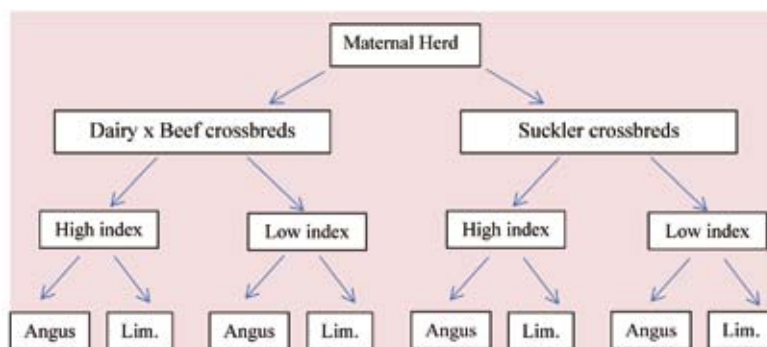
### Introduction

Profitable suckler based beef production systems require a cow that will efficiently produce a weanling with good weight-for-age from a grazed grass diet and is capable of achieving a 365-day calving interval. Other drivers of profitability in suckler beef systems include stocking rate, mean calving date, age at first calving, number of live calves per cow per year and slaughter age of progeny. However, all these drivers depend on adequately matching the cow type to the prevailing environment which, from an Irish perspective, is a pasture-based production system. Herd genetic improvement plays an important role in overall farm profitability by facilitating optimal breeding decisions that have the potential to increase long-term animal productivity. Current industry statistics show that, on average, Irish suckler cows have calving intervals of 407 days; produce 0.82 calves per cow per year and only 18% of heifers calve for the first time between 22 to 26 months of age. This level of performance highlights the current inefficiencies of the national suckler herd and the scope for improvement. In this context, a comprehensive review of the Euro-star replacement index was implemented nationally in May 2015. This revision led to a greater emphasis placed on the key maternal traits, which are proven to underpin farm profitability. In order to ensure continued accurate genetic evaluations the profit traits included in the index, together with their respective economic weighting, must be regularly reviewed.

### Design and establishment of the *Maternal Herd*

The *Maternal Herd* was assembled in 2012 with the purchase of maiden heifers (weanlings) from commercial farms throughout the country. Heifers were selected from two main sources, reflective of replacement heifer options for Irish suckler herds: 1) beef crossbred heifers bred from dairy cows and, 2) beef crossbred heifers sourced from suckler herds (Figure 1). Heifers were selected based on their sire's Replacement Index, with particular emphasis on breeding values for the key maternal profit indicator traits (i.e. age at first calving, calving interval, maternal weaning weight and maternal calving difficulty). Only heifers from sires with high

reliability (>70%) for the Replacement Index were selected. A further objective was to create two contrasting genetic groups by selecting heifers of either high or low genetic merit for maternal traits. Additionally, within dam type (dairy vs beef cows), heifers were sired by either Angus (early-maturing breed) or Limousin (late-maturing breed) bulls. Sire verification was carried out for all animals before purchase. Heifers calved for the first time in spring 2014 and approximately 30 replacement heifers have been introduced into the herd each spring, thereafter. Since its establishment in 2012 lactating heifers from 42 sires are represented in the study. Sires of high Replacement Index animals include: MPD, LSC, PBO, GIP, FL21, FL22, OMA, CVV and S511, while those of low Replacement Index include: WLU, SYT, CMJ, PTN, ERW, PAM, NUF, TON, TKO and MBU.



**Figure 1.** Summary of the composition of the Maternal Herd (Lim = Limousin).

## Predicted differences

The difference in the predicted economic value is comprised of a multitude of factors including production performance, cow survival, feed intake, carcase traits etc. Table 1 details the economic indexes (Replacement Index, Maternal cow traits and Maternal progeny traits) and predicted transmitting ability (PTA) cow differences for a range of important production parameters.

**Table 1.** Descriptive statistics for the Maternal Herd

	Genetic merit		Expected PTA difference
	High	Low	High vs. Low
Replacement Index (€)	119	50	69
Maternal cow traits (€)	84	17	67
Maternal progeny traits (€)	35	33	2
Calving difficulty score (%)	3.37	5.05	1.68 units easier
Cow weight (kg)	14	25	11 kg lighter
Gestation length (days)	0.53	1.76	1.23 days shorter
Age at first calving (days)	-16.2	-7.2	9 days younger
Maternal weaning weight (kg)	12.1	5.3	6.8 kg heavier
Direct carcase weight (kg)	7.0	10.8	3.8 kg lighter



Herd management is similar to a commercially managed suckler herd and detailed measurements of key performance traits are recorded. These measurements include: age at onset of puberty, milk production, reproductive efficiency, weaning weight, body weight change and body condition score, as well as, detailed feed intake and energy balance measurements.

## Preliminary results

Low genetic merit cows had a greater body condition score (BCS) (0.08 units) at breeding than high genetic merit cows and were numerically heavier (+12 kg) throughout lactation. Beef × dairy cows were 53 kg lighter and had a lower BCS (-0.22) at breeding than beef bred cows. Age at first calving, calving interval, pregnancy rate and other reproductive variables investigated thus far were similar for both High and Low Replacement Index groups (Table 2). Similarly, age at first calving, calving interval, all reproductive variables investigated thus far were similar for beef × dairy and beef crossbred cows. However, based on two years data, it is too early to be definitive on differences in reproductive efficiency.

**Table 2.** Effect of Replacement Index group and cow origin on reproductive performance traits

	Replacement Index		Cow origin	
	High Genetic Merit	Low Genetic Merit	Dairy	Beef
Body weight (kg)	585	597	533	586
Age at first calving (d)	756	758	750	761
Body condition score at breeding (0-5)	2.70	2.78	2.64	2.86
Calving to service interval (d)	61	58	59	61
Submission rate in first 24 days (%)	67	55	70	44
Pregnancy to first service (%)	50	48	40	48
6 week in-calf rate (%)	56	57	53	47
Pregnancy rate (%)	89	86	90	82
Calving to conception interval (days)	77	74	77	78
No. of services per cow (n)	1.81	1.65	1.82	1.75
Actual calving interval (days)	360	354	359	356
Mean calving date	20 March	26 March	18 March	26 March

High genetic merit cows produced 1.1 kg more milk per day than Low genetic merit cows (Table 3). Results to date indicate that genetic merit did not influence calf birth weight, calf average daily gain (ADG), weaning weight, calf quality or calf value. Beef × dairy cows had a greater milk yield (+1.9 kg/day) than beef crossbreds. Calf birth weight was similar for both groups but calf ADG and consequently weaning weight was greater (+16 kg) for calves from cows generated from the dairy herd. Calf quality score was similar for calves from beef × dairy crossbred cows and beef crossbred cows. Consequently, calf price per kilogram bodyweight was greater for calves from the beef herd (€2.71/kg for calves from beef cows and €2.61/kg for calves from dairy crossbred cows). Despite this however, consistent with their weaning weight advantage, calf value at weaning was €13 greater for calves from dairy crossbred cows compared to beef cows.

**Table 3.** Replacement Index group and cow origin on calf performance. <sup>1</sup>ADG= average daily gain

	Replacement Index		Cow origin	
	High Genetic Merit	Low Genetic Merit	Dairy Crossbred	Beef
Milk yield (kg/d)	7.8	6.7	8.2	6.3
Calf birth weight (kg)	42	43	41	43
Weaning weight (kg)	294	288	301	285
Calf ADG <sup>1</sup> (kg)	1.07	1.05	1.10	1.04
Calf quality (1 to 5)	3.23	3.24	3.19	3.26
Calf value (€)	783	777	785	772

## Performance in 2016 to-date

Calving commenced on 25 January and finished on 16 May. A total of 118 cows produced 121 calves. Overall calving performance of the herd was exceptional; one set of twins, one set of triplets, three caesarean sections and four calf losses were incurred. Mean calving date was 14 March (6 days earlier than the previous year). Average calf birth weight was 44 kg and calving score was 1.5 (scale, 1= calved on her own to 5= caesarean section). Cows and calves were turned out to pasture on 10 March. All calves were vaccinated against IBR at ten days of age and received a booster vaccine at three months of age. Calves were treated with Cevazuril against Coccidiosis at three weeks of age. Cows were vaccinated against Leptospirosis and BVD one month before breeding commenced.

The breeding season commenced on the 27 April, this year. Similar to last year, cows were artificially inseminated for nine weeks with stock bulls turned out for the subsequent four weeks. Cows were bred to high Terminal Index Angus and Limousin sires. The Angus sires used were GJB, FPI, ZFL, AA2259, AA2163 and JZJ, while the Limousin sires included MBP, KJB, LM2188, LM2206, YHW and GWO. Two Angus bulls (ZLT and AA2025) and two Limousin bulls (ZAG and GZP) were selected for breeding the heifers. Each year, sires are used equally across all cow groupings (dairy vs. beef crossbreds; High vs. Low Replacement Index) to facilitate an equitable comparison of resulting progeny.

## Conclusion

The *Maternal Herd* is a valuable resource for collecting detailed information pertinent to maternal traits in suckler cows. Results to date show that, with the exception of small differences in body weight, BCS and milk yield, genetic merit for the Replacement Index has no influence on production performance. However component traits such as carcass performance of the progeny, lifetime production efficiency and cow survival have not been evaluated to-date. It is planned to collect a further two years of cow and calf performance records, following which, a comprehensive analysis of the potential of the Replacement Index to identify females with increased genetic merit for maternal traits will be available

## Genomics and fertility in beef cattle

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### Summary

- Differences exist between individual animals in the DNA sequence of genes controlling reproductive traits and this, in turn, contributes to observed variation in fertility.
- Genetic gain for cow fertility, using traditional selection approaches, is often hampered due to low heritability and difficulties in accurate measurement of the component traits, including some traits only being measurable in mature females.
- National genomic evaluations were implemented for dairy cattle in Ireland in February 2009 and will be launched shortly for beef cattle.
- Genomic research in Teagasc aims to facilitate the selection of cattle with superior genetic merit for key reproductive traits including earlier onset of puberty, improved conception rate as well as facilitating a better understanding of the reproductive response to nutritional and other management interventions.

### Introduction

Genomics can be simply defined as the study of genes and their functions. From a livestock breeding perspective, the main application of genomics is to improve our understanding of the regulation of important cellular processes that govern the expression of economically important traits and to use this information to identify animals with superior genetic potential for these traits. Recently available knowledge on the sequence of DNA within the chromosomes of individual cattle, is being used to predict the animal's genetic merit for economically important traits, such as fertility. There are approximately 22,000 genes in the cattle genome. While all cattle contain the same genes, differences exist between individual animals in the DNA sequence of these genes. This variation in units of DNA (called nucleotides) between members of a species are called **single nucleotide polymorphisms** (or genetic markers), abbreviated to SNPs (pronounced "snips"). It is these differences in the DNA sequence between animals that are principally responsible for variation between animals for economically important traits including cow fertility. However, environmental factors such as nutritional management, can also influence the expression of genes controlling these traits. Research in Teagasc is focused on establishing the key genes controlling traits such as early onset of puberty, conception rate and the role of nutrition in modifying the expression of these genes. For example, it would be important to determine whether the apparent genetic advantage of animals when measured under one management system (i.e. high input grain based) is consistent across other contrasting production systems such as those based on pasture.

### Genomics

The rapid advancement of genomic technologies provides the tools for an improved understanding of the underlying biological mechanisms involved in puberty, the establishment of pregnancy, improved embryo survival and the response of reproductive traits to various

nutritional and other management interventions. Following the release of the cattle genome sequence in 2009, the study of cattle genomics has expanded dramatically. Current molecular technologies provide the opportunity to explore genes and their DNA sequences in detail, and facilitate the search for specific genomic markers for improved fertility potential. Such information can then be incorporated into breeding objectives in order to increase the rate of genetic progress for the specific traits of interest. Because of the difficulties associated with the accurate and routine measurement of many fertility related traits, the delay in expression of many traits (i.e. often only measurable in mature animals), together with their apparent low heritability, the response to traditional genetic selection approaches has often been slow. The advent of genomically assisted selection approaches (discussed below), will facilitate earlier and more reliable prediction of an animals' genetic merit for key reproductive traits thus underpinning more informed selection decisions.

## Current research in genomics and future applications

The critical importance of reproductive efficiency to the financial sustainability of suckler cow herds is undisputed and thus a fundamental understanding of reproductive traits and how they are regulated is a key aim of the Animal and Bioscience Research Department, Teagasc Grange. For example, age at onset of puberty in both male and female cattle, conception rate and the duration of the interval between successive calvings are all under varying degrees of genetic control and exhibit considerable inter-animal variation, even where animals are managed similarly. Differences in the sequence of DNA between animals is being compared with their measured performance in key traits with a view to identifying differences in sequence (i.e. SNP) that result in superior genetic potential of some animals compared with their contemporaries.

*Early onset of puberty:* The target age for first calving in beef heifers is 24 months and this is a key trait underpinning the reproductive efficiency of a herd. Despite this, only a small proportion of beef heifers in Ireland meet this important target, leading to significant increased production costs. Puberty, or the progression to sexual maturity, is a developmental process which exhibits significant genetic variation, observed in differences between breeds as well as differences between animals within a particular breed. Age at puberty is moderately heritable, and detection of the genes critical to controlling this process is one of the aims of our research. However, the trait, like most important livestock traits is complex with its polygenic nature, i.e., many genes contribute to the expression of the trait, each with small effects, making it difficult to identify and characterize markers for genetic prediction.

Despite its obvious importance, age at puberty is a trait that is very difficult to routinely measure directly in practice, thus requiring the availability of accurate and cost effective biological markers, if improvements are to be made. In addition to its genetic influence, the trait is heavily influenced by the nutritional management of the animal, particularly in early life. For example, heifers fed diets that promote rapid rates of bodyweight gain in early life (<6 months of age) reach puberty earlier and at lighter bodyweight. Indeed, we have recently generated exciting data from dairy bred bull calf studies, which clearly shows that plane of nutrition in the first six months has a major impact on the date of expression of puberty. This effect is not found with improved nutrition during the second six months of life. Therefore, a critical window for nutritional imprinting of the complex brain-ovarian-hormonal interactions that regulate age at which sexual maturation occurs appears to exist early in juvenile development. We are currently studying the expression of genes in key regions of the

brain as well as the ovary in heifers and testes in bulls that regulate the interaction between diet and reproductive processes with the aim of identifying genes important to earlier onset of puberty. This information can facilitate improved nutritional management for the rearing of breeding heifers and bulls and contribute to genomic selection programmes for beef cattle.

*Reducing early embryonic loss:* The greatest single contributor to reproductive wastage in cattle is early embryonic loss, mainly occurring between 8 to 16 days after conception. Appropriate signaling and communication between the embryo and the dam is vital at this time to ensure recognition and establishment of pregnancy. Thus the cow's uterus or womb plays a central role in the success of pregnancy establishment. We recently investigated the genomic control of uterine function in two groups of beef heifers of contrasting fertility performance. Crossbred beef heifers were inseminated and pregnancy diagnosis was carried out 28 days later, after which animals were programmed to return to oestrus. Animals were re-inseminated followed by pregnancy diagnosis on a further four occasions. On the basis of pregnancy rate to 4 successive inseminations, animals were divided into two groups: i) those that established pregnancy on all 4 occasions (high fertility group) and ii) animals achieving pregnancy on only one occasion (low fertility group). Oestrous cycles were then synchronised and half of the animals from both high and low groups were slaughtered on day 7 of their oestrous cycle. Uterine endometrial tissue (lines the uterine wall), which is critical to supporting pregnancy, was collected from all animals. The remaining animals were slaughtered and tissue collected on day 14 of the oestrous cycle. Endometrial gene expression was analysed. We found that changes in gene expression were correlated with a number of key biochemical pathways involved in the functioning of the uterus. Genes and molecular pathways involved in metabolite transport, lipid metabolism and inflammation were altered between high v low fertility heifers on both days 7 and 14 of the oestrous cycle. We also carried out sequencing analysis of these genes and discovered a panel of novel genetic variants exhibiting significant associations with fertility traits which, following further validation may contribute to the national genomic selection breeding programme for beef cattle.

*Bull fertility:* Genomic technology can also be used to identify both genetically superior and potentially more fertile bulls. With the advent of genomically assisted selection technology, bulls can now be identified as potential artificial insemination (AI) sires within weeks of birth. It is desirable not only for these bulls to reach puberty and sexual maturity as early as possible but also to have the capability of producing high volumes of good quality semen throughout their life. Indeed, industry statistics show that there is considerable variation within both AI and natural service bull populations for fertility potential. Current work in Teagasc aims to characterise genetic markers of early pubertal development as well as subsequent semen quality for both AI and natural service bulls.

*Effect of nutrition on reproductive efficiency:* Nutrition has been shown to have a central role in influencing the reproductive performance of cattle. One study which we conducted examined the effect of supplementing the diet of beef heifers with polyunsaturated fatty acids (PUFA) found in fish oil. Consistent with the approach outlined above, the expression of key uterine endometrial genes were measured in the animals that were supplemented with PUFA, before and during early pregnancy. We found a positive correlation between changes in abundance of key endometrial genes potentially providing a more favorable uterine environment and decreasing the risk of early embryonic loss. Diet has also been shown to have an effect on the molecular regulation of many other aspects of the reproductive process including ovarian



function, onset of puberty, as outlined earlier and the resumption of normal ovarian cyclicity and oestrus or heat activity following calving in cows.

*Genomic selection:* Improving genetic gain in cow fertility using traditional selection approaches is often very slow for a number of reasons including typical low heritability of the component traits, difficulties for accurate measurement and in some instances the key traits may only be measured in mature females. However, the incorporation of genomic information into breeding programmes has the potential to significantly increase the rate of genetic gain in complex economically important traits, such as fertility. The ability to accurately identify elite animals at a young age without the requirement for formalised progeny testing offers significant opportunities to increase genetic gain as well as to reduce the costs of a breeding programme. The fundamental basis of genomic selection in cattle is the quantification of the combined impact of thousands of SNPs on performance traits, including fertility. Once identified, the DNA profile of a selected candidate (e.g. a young test bulls) can be generated and the sum of the estimated effects of all DNA variants for that individual animal obtained, resulting in an estimate of the genetic merit of that individual which can be made available at a very young age. The biggest impact to-date of genomic selection to the cattle industry has been to significantly increase the reliability of breeding values in the absence of own performance or progeny test information. This is particularly true for low heritability and, or difficult to measure traits, such as many of those related to reproductive performance. Genomic information is now included in many advanced dairy cattle breeding programs, throughout the world and will be launched shortly in Ireland for beef cattle genetic evaluations.

*Irish Dairy Beef custom SNP chip:* Breeding tools (referred to as “SNP chips”) have been developed to screen and quantify, an animal’s status for tens of thousands of genetic markers simultaneously. In Ireland, a genomic selection breeding programme was initiated in 2009 for the dairy industry. A custom made SNP chip (referred to as the International Dairy Beef (IDB) chip) was initially developed in 2013 by a collaborative (Teagasc, Weatherby’s Ireland, Irish Cattle Breeding Federation and USDA) working group with the central aim of establishing a custom SNP chip that could be used to aid implementation of genomic selection for both dairy and beef cattle in Ireland. Indeed this resource is currently used for genetic evaluations, parentage, screening for lethal recessives, congenital disorders and other mutations with large effects on performance in cattle (see: [www.icbf.com](http://www.icbf.com)). The SNP chip has been designed using microarray technology so that thousands of genetic markers (SNPs) can be identified simultaneously in DNA samples from an individual animal. Such a large number of SNPs are necessary for genomic evaluations given the polygenic (controlled by many genes) nature of most economically important traits in livestock. Since 2013 the IDBv1, IDBv2 and more recently, IDBv3 have been routinely used as part of the Irish genomic selection breeding programme. The chip is revised annually and a portion of the SNPs are reserved for variants relevant to research studies. The current version, IDBv3, includes over 50,000 genetic variants and is now employed in national genomics selection breeding programmes including the Beef Data and Genomics Programme. The chip includes over 1000 SNPs identified in the published literature or through research at Teagasc as showing significant association with fertility and reproductive phenotypes. Genetic markers associated with variation in reproductive potential and discovered through the Teagasc research programme are continuously being incorporated onto the IDB SNP platform for future validation and therefore, will be readily exploitable by Irish beef and dairy farmers.

## Bull fertility: important issues and current research

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### Summary

- The stock bull is typically the most valuable animal in the herd and has the single greatest influence on herd fertility and genetic merit.
- It is essential that vigilance for bull fertility and mating performance is maintained on an on-going basis throughout the breeding season.
- Up to 5% of bulls can be infertile while up to 25% experience subfertility.
- Appropriate attention must be given to the nutritional, health and housing management of stock bulls.
- Current Teagasc research is examining the nutritional and genomic control of puberty and fertility in bulls.

### The stock bull – often overlooked and underappreciated!

Natural service is the predominant breeding strategy used on Irish suckler cow herds; over 80% of calves born annually are sired by stock bulls. Consequently, given the small herd size and predominate use of single-sire mating, the fertility of the stock bull is of major importance to both the number of calves produced and the calving spread within a herd. Indeed, level of fertility is much more important for an individual bull than for a cow, given that the former may be used to breed up to 40 females during a normal breeding season. Furthermore, while a bull may have a 4- or 5-star rating for genetic merit, this is solely a prediction of his progeny's production potential and has no bearing on the bull's own ability to get cows pregnant. While the reported incidence of sterility is generally low (<5%), subfertility, at a consistent level of 20-25%, is much more common in breeding bulls, with significant differences in fertility among individual animals. Subfertility may be caused by low libido, sperm quality/quantity, defects or physical factors affecting bull mobility or mating ability.

While a sub fertile bull may be capable of getting some cows pregnant, it will result in low pregnancy rates, an extended calving interval, reduced calf weaning weights and higher involuntary culling of cows for barrenness, unless the bull is operating within a herd with a very low cow: bull ratio. Frequently, subfertile bulls go undetected and herdowners may be unaware of the problem until much of the breeding season has elapsed or until such time that cows are checked for pregnancy. Furthermore, there is no guarantee that a bull will retain his fertility from season to season or even within a season. Thus, herd owners must be continually vigilant for potential fertility problems and keep breeding records of when cows are bred so that corrective action can be taken before it is too late.

### Scrotal characteristics and bull fertility

Scrotal circumference increases with bull age, most rapidly between 6 months and 2 years, typically peaking at 3 years of age. Research has shown that it is highly correlated with paired

testis weight, which is, in turn, positively related with daily sperm production and semen quality. Generally, bulls with larger, even sized, testes produce more and better quality sperm. Additionally, the heritability of scrotal circumference is relatively high and there is some evidence for a positive relationship between sire scrotal circumference and daughter fertility. On the contrary, however, an excessively large scrotal circumference and, or a pendulous scrotum, is undesirable as it can lead to injury to the testicles which may render the bull infertile. Because of its relationship with overall reproductive potential and usefulness in identifying unsatisfactory bulls, scrotal circumference measurements are now a pre-requisite for entry to many bull sales.

It is now also well established, that for the production of fertile sperm, the temperature of the testes must be 2-6°C lower than core body temperature. Increased testicular temperature, irrespective of the cause, reduces semen quality and is probably the most common cause of infertility in bulls. The duration for which semen quality declines following a thermal insult would appear to be related to its severity and duration, with sperm morphology returning to normal within 6 weeks of the end of the increased temperature, though resumption of normal fertility may take somewhat longer. As discussed later, increased scrotal temperatures may be a consequence of contraction of disease, injury or indeed due to an increase in the fatness of the scrotum as a consequence of an excessively high plane of nutrition.

## Health management

The purchase of a stock bull is one of the largest routine investments made by herd owners and thus, the health of such valuable animals should be protected appropriately. For example, as mentioned earlier, any event that leads to a rise in the temperature of the scrotum, including inflammation or fever as a consequence of contracting a disease, can lead to damage to developing sperm cells and therefore temporary infertility. Pedigree bulls are often raised in small herds and, thus, on introduction to a new herd can be immune-compromised when exposed to diseases such as infectious bovine rhinotracheitis (IBR), pneumonia, respiratory syncytial virus (RSV), leptospirosis, to name but a few.

Disease prevention management for bulls should, essentially, be the same as for breeding females in the herd and veterinary advice on prophylactic care including vaccination programmes and parasite treatments should be sought. New animals introduced to the herd, should be screened for infectious agents prior to entry, if possible, or at least quarantined on the farm following purchase until test results are available. In many 'closed herds' purchase of a stock bull is the only animal movement into the herd and could, potentially, be a significant vector of disease. Bulls should only be purchased from reputable breeders who have an appropriate herd health management plan in place. Indeed, many of the main breed societies have strict health criteria and testing requirements that must be met before entry of animals is accepted to sales. Maintaining good hoof and limb health are also of critical importance to both the longevity and fertility of bulls. For example, data from a Swedish veterinary study found that, from a population of relatively young beef bulls culled for infertility, most had evidence of arthritic lesions in their limbs, though they did not show overt signs of lameness. Joint lesions should, therefore, be taken into consideration as a possible contributory cause of reproductive failure in bulls with or without symptoms of lameness.

## Breeding Soundness Evaluations

Because of the serious implications of an infertile or subfertile bull on herd productivity, a Bull Breeding Soundness Evaluation (BBSE), or pre-breeding examination is now widely

recommended in order to aid the identification of potential fertility issues in advance of the onset of the breeding season. Ideally, a BBSE should be conducted on a yearly basis by a veterinary surgeon at least 60 days prior to the start of the breeding season. This will facilitate re-testing and ultimately timely replacement of bulls that may fail the examination.

The British Cattle Veterinary Association (BCVA) recently introduced a certification protocol for evaluating bulls and a number of Irish veterinary practices are BCVA accredited. These are offering this bull fertility assessment service to herds for breeding purposes which involves 4 main steps: i) *physical examination*, ii) *semen examination*, iii) *assessment of mating ability* (not generally performed) and, iv) *classification or overall prognosis*. While this, or indeed any of the systems used, do not classify a bull as “fertile” or “infertile” their objective is to reduce the risk of poor fertility performance in stock bulls. Those classified as “satisfactory” will have reached minimum criteria for semen quality, scrotal circumference and no evidence of physical abnormalities have been found. Bulls with a low sperm count, with serious semen or physical defects, or which fail to meet minimum criteria for scrotal circumference are classified as “unsatisfactory” for potential stock bulls. A recent survey by our research group of stock bulls which underwent a routine BBSE (i.e pre-sale or pre-breeding BBSE) identified that 25% of bulls failed. While these evaluations identify bulls with substantial deficits in fertility, they do not consistently identify subfertile bulls. Indeed, given that bull fertility is influenced by a wide range of factors, no single diagnostic test can accurately predict fertility, although an appropriate combination of tests can be more informative and will help to avoid costly incidents of infertility.

## Observation during the breeding season

During the breeding season it is important to check a bull for locomotion, any evidence of injury or arthritic problems, and that he is physically capable of mating cows. The best evidence of a bull’s fertility potential is his ability to get cows pregnant. Therefore, it is advisable to record the identity of the first cows bred and either diligently check these cows for repeat to service or confirm pregnancy by ultrasonically scanning the cows 28-35 days after breeding. This is particularly important for young bulls joining the herd. While it is impossible to be precise regarding the exact number of cows to assign to a bull, given the many factors that can affect potential fertility, the general recommendation for yearling bulls is 20-30 cows; with up to 50 cows assigned to mature bulls of proven fertility.

## Nutrition and bull fertility

Young bulls well grown for age will typically commence sexual activity earlier and have achieved a higher level of semen quantity and quality at the start of the breeding season than poorer performing contemporaries. This is the consequence of a complicated hormonal interplay between the brain, metabolic organs and the testes. Indeed, we and others have recently shown a positive effect of early life nutrition (up to ~ 6 months of age) on the age at which bull calves subsequently reach puberty, with very well-fed calves reaching puberty approximately 4-8 weeks ahead of their contemporaries maintained on a lower plane of nutrition. Indeed, our data suggest that if a bull calf has been exposed to a low plane of nutrition in the first 6 months of life (which can frequently occur with calves suckling cows with poor milk supply), increasing their feeding level, thereafter, will not appreciably advance puberty.

In general, the published information, to-date, on the effect of nutritional management on reproductive characteristics of young bulls would suggest that a balanced diet, consistent with achieving moderate to high (1.0-1.2 kg) growth rates throughout the first 12 months

of life. This will ensure that producers can achieve the dual aims of ensuring bulls reach the required growth targets, while also achieving early onset of puberty and normal subsequent fertility. Following purchase and movement to a new herd, young bulls should be gradually transitioned from the high plane of nutrition typical of pre-sale rearing regimens to a moderate diet that should be offered during the breeding season and beyond. This requires that bulls are purchased well in advance (ideally two months) of being joined with the cow herd. Indeed, too often, young bulls are turned out with cows very quickly following purchase, leading to dramatic loss of weight and body condition which can have implications for their subsequent fertility.

The specific dietary protein requirements to support reproductive development and fertility in bulls has not been examined; suffice to say that it appears to be consistent with the protein and amino acid requirements for normal growth. Similarly, while a number of trace elements (i.e. manganese, selenium, zinc) have been cited as being important to testicular function and sperm development, there is a lack of studies that have examined this subject in any detail and accurate information on the precise requirements to support optimal sperm development is needed. Prior to the onset of the breeding season mature bulls should be managed at least as well as their cow contemporaries and fed to attain a moderate level of body condition score (~3.5 on a 5-point scale); the concept of being 'fit but not fat' is applicable.

## **Genomics of bull fertility and future developments**

As discussed earlier, a number of key fertility traits in bulls including scrotal size and sperm production capacity are known to be heritable and thus, facilitate genetic selection. The identification of genes in cattle, which have been shown to regulate fertility in other species, holds significant promise for understanding the regulation of fertility in bulls. On-going research by our group, funded by the Department of Agriculture, Food and the Marine, is examining key genes regulating the onset of puberty in young bulls and how these are affected by prevailing plane of nutrition. Internationally, studies are examining the relationship between specific differences in the DNA sequence of individual bulls and their reproductive performance. Progress is slow, given the difficulty in procuring accurate information on the fertility status of bulls to compare with their DNA profile. Despite this, the advent of portable automated electronic technology that can conduct multiple tests on semen samples to better characterise sperm fertility and viability will aid with more accurate diagnostic and prognostic evaluations of a bull's reproductive capacity. Additionally, consistent with current plans for female fertility traits, such information for bull fertility traits could, in future, be incorporated into national genomically assisted breeding programmes for beef cattle, which will be aided by the current Beef Data and Genomics Programme.

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# **Technology Village:**

## **Sustainable Farm Environment**

## Sustainable land drainage design

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### Summary

- The first step of any drainage works is a detailed investigation into the causes of poor drainage using soil test pits.
- Two main types of drainage system exist: a groundwater drainage system and a shallow drainage system. The design of the system depends entirely on the drainage characteristics of the soil.
- Distinguishing between the two types of drainage systems essentially comes down to whether or not a permeable layer is present (at a workable depth) that will allow the flow of water with relative ease. If such a layer is evident a piped drain system is likely to be effective, at this depth. If no such layer is found during soil test pit investigations, it will be necessary to improve the drainage capacity of the soil. This involves a disruption technique such as moling, gravel moling or subsoiling in tandem with collector drains.
- Clean aggregate in the 10–40 mm (approximately 0.4 to 1.5 inch) grading band should be used around drain pipes.
- Most land drainage systems are poorly maintained. Open drains should be clean and as deep as possible and field drains feeding into them should be regularly rodded or jetted

### Introduction

Approximately 50% (3.4 m ha) of the total land area of Ireland is classified as “marginal land” which is affected by natural limitations related to its soil, topography and climate. The major limitation of this marginal land is its poor drainage status and much is in need of artificial drainage if its productivity is to be improved. Grass yields are limited due to the adverse effect of excess water and a lack of air at rooting depth, which limits plant respiration and growth. In cases of prolonged waterlogging, plants will eventually die due to a lack of oxygen in the root zone. Furthermore, waterlogged soils are impassable to agricultural traffic (both machinery and livestock) for long periods, due to high soil moisture content and reduced soil strength. This reduces the number of grazing days and hinders silage harvesting, thus introducing higher costs related to imported feedstuffs.

The purpose of land drainage is to remove excess water from the soil as quickly as possible. How best to achieve this will vary with soil type. There is a need therefore for a better understanding of the underlying causes of drainage problems and of the design and implementation of appropriate drainage systems to resolve these problems. We must move away from the short-sighted approach that a broadly similar drainage system can be installed in every wet field regardless of soil and site conditions and ensure our poorly-drained lands are improved in a sustainable fashion. When planning any drainage programme, the potential of the land to be drained needs to be first assessed to determine if the costs incurred will result in an economic return through additional grass yield and/or utilisation. Some thought is

needed in deciding the most appropriate part of the farm to drain. From a management point of view it is better to drain that land which is nearer to the farmyard and work outwards; however, it may be more beneficial to target areas with high potential for improvement. This ensures a better return on the investment.



**Figure 1.** Surface waterlogging on poorly-drained grassland (left) and drainage installation (right).

## Drainage investigations

- ▶ What exactly is the problem?
- ▶ How good is the existing drainage network (if any)?
- ▶ Is the whole profile made up of poor soils or is the problem caused by specific layers?
- ▶ Is there water movement at any depth?

Knowledge of previous drainage schemes in the area, and their effectiveness will often provide an insight. A number (approximately 1 per ha) of test pits (at least 2.5 m deep) should be excavated within the area to be drained to investigate. These are dug in areas that are representative of the area as a whole; consider digging in wet and dry areas for comparison sake. As the test pits are dug, the faces of the pits are observed, soil type should be established and the rate and depth of water seepage into the test pit (if any) recorded. Visible cracking, areas of looser soil and rooting depth should be noted as these can convey important information regarding the drainage status of the different layers. The depth and type of the drain to be installed will depend on the interpretation of the characteristics revealed by the test pits. Broadly speaking, there are two main categories of land drainage:

- *Ground water drainage system:* This comprises a network of deeply installed piped drains exploiting permeable layers.
- *Shallow drainage system:* Where the permeability (the ability of the soil to allow water to move through it) of the soil is low at all depths and needs to be improved, a shallow drainage system is required.

## Groundwater drainage system

In soil test pits where there is strong inflow of water or seepages from the faces of the pit walls, layers of high permeability are present. If this type of scenario is evident on parts of your farm it would be best to focus on these areas first as the potential for improvement is usually very high. Under these circumstances the use of a piped drainage system is advised.



The installation of a piped drain at the depth of inflow will facilitate the removal of ground water assuming a suitable outfall is available. Conventional piped drains at depths of 0.8 to 1.5 m below ground level have been successful where they encounter layers of high permeability. However, where layers with high permeability are deeper than this, deeper drains are required. Deep piped drains are usually installed at a depth of 1.5-2.5 m and at spacings of 15-50 m, depending on the slope of the land and the permeability and thickness of the drainage layer. Piped drains should always be installed across the slope to intercept as much groundwater as possible, with open drains and main piped drains running in the direction of maximum slope. Clean aggregate, in the 10 – 40 mm grading band, should be used to surround the drain pipe. The gravel should be filled to a minimum depth of 300 mm from the bottom of the drain to cover the pipe. The stone should provide connectivity to a layer of high permeability and should not be filled to the ground surface.



**Figure 2.** Test pit excavation (left) and drainage trench excavation (right).

## Shallow drainage system

Where a test pit shows little ingress of water at any depth, a shallow drainage system is required. These soils with no obvious permeable layer and very low hydraulic conductivity are more difficult to drain. Shallow drainage systems are those that aim to improve the capacity of the soil to transmit water by fracturing and cracking it, these include mole drainage and gravel mole drainage. Mole drainage is suited to soils with high clay content, which form stable channels. Mole drains are formed with a mole plough comprised of a torpedo-like cylindrical foot attached to a narrow leg, followed by a slightly larger diameter cylindrical expander. The foot and trailing expander form the mole channel, while the leg creates a narrow slot that extends from the soil surface down to the mole channel depth.

The success of mole drainage depends on the formation of cracks in the soil that radiate from the tip of the mole plough at shallow depth. Gravel filled moles employ the same principles as ordinary mole drains but are required where an ordinary mole will not remain open for a sufficiently long period. This is the case in unstable soils having lower clay content. The mole channel is formed in a similar manner but the channel is then filled with gravel which supports the channel walls. The gravel mole plough carries a hopper which controls the flow of gravel. During the operation the hopper is filled using a loading shovel or, alternatively, a belt conveyor from an adjacent gravel cart. Gravel moles require a gravel aggregate in the



10-20 mm size range to ensure they function properly. Sub-soiling is used effectively where an iron pan or 'cemented' layer impedes drainage. The effect is to break the layer and crack the soil. A stable channel will not be formed. Collector drains, which are installed across the slope at 0.8-1.0 m deep, are required for all shallow drainage systems. Depending on the topography and slope, the collector drains will be at a spacing of 10-40 m. A larger spacing reduces costs but results in a much higher chance of failure. The mole or gravel mole channels are drawn at right angles to the collectors (up-slope) at spacings of 1.0-1.5 m and a depth of approximately 0.4-0.5 m. Stone backfill for collectors should be filled to within 250 mm of the surface to ensure interconnection with the disruption channels when installed afterwards.

## Outfalls/Maintenance

Every drainage scheme is only as good as its outfall. Cleaning and upgrading of open drains acting as outfalls from land drains is an important step in any drainage scheme. Before commencing land drainage the proposed outfall should be assessed and where necessary upgraded. Open drains, running in the direction of maximum slope, should be established to as great a depth as possible. Spoil from such works, where suitable, can be spread over the adjoining land filling depressions and should not impede surface runoff to the watercourse. Unsuitable spoil should be buried and covered with topsoil or removed to waste ground.

When a drainage scheme has been completed, the layout should be drawn and noted on a farm map. This map can then be used as a guide when maintaining the works, as well as a record of the works. Land drain outlets should be regularly cleaned and maintained especially if open drains are cleaned/upgraded as this will result in blockages at the drain outlets. The use of a concrete or un-perforated plastic pipe over the end of the drain pipe, minimum 1 m in length, will protect the outlet from damage and will make locating and maintaining it easier. Drainage pipes need to be flushed out regularly (3-5 year intervals) to remove sediment, root and iron ochre blockages.



**Figure 3.** Examples of blockages in drainage pipes.

## Land drainage publications

The Teagasc Manual on Drainage and Soil Management is available from Teagasc offices or can be ordered online via the Teagasc website [www.teagasc.ie/publications](http://www.teagasc.ie/publications). Search "Teagasc Manual on Drainage and Soil Management". A freely downloadable guidebook is also available. Search "Land Drainage".

## Lime - the key to sustainable grass production on drystock farms

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### Summary

Reducing grassland soil acidity by applying lime is essential for maintaining good soil fertility and achieving sustainable grass production targets on beef farms.

- Aim to maintain soil between pH 6.3 to 6.5 on mineral soils.
- Take soil tests from each field to establish the quantity of lime required.
- Prepare a lime plan to facilitate the correct lime application across your farm.
- Ground limestone is most cost-effective for long-term soil acidity control.

The benefits of correcting soil pH through liming include the following:

- Release of soil nitrogen (N) for grass growth (up 80 kg N/ha/year).
- Increased plant availability of soil phosphorus (P) and potassium (K).
- An extra 1.0 to 1.5 t grass dry matter per hectare grown annually.
- A return on investment of approximately 6:1.

### Introduction

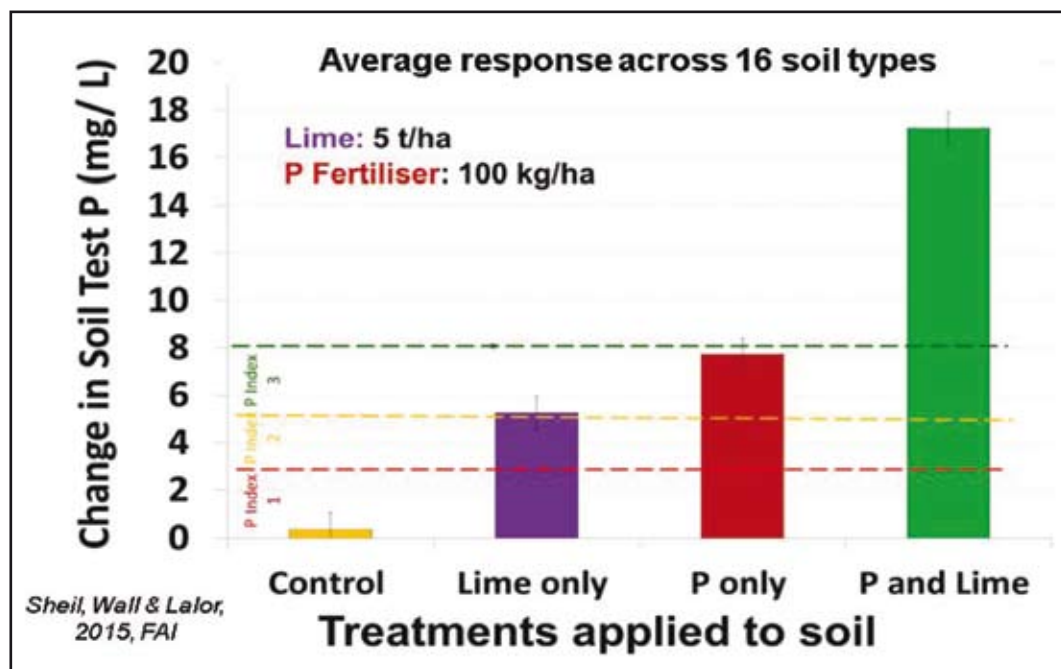
Soil fertility is a key component of growing sufficient grass on an annual basis. Irish soils are acidic by nature due to our high annual rainfall. Soil acidity reduces the availability of major soil nutrients such as nitrogen (N), phosphorus (P) and potassium (K). It reduces the uptake and plant utilisation efficiency of applied nutrients in fertilisers and organic manures. Soil test results show that 90% of grassland soils are suboptimal in one or more of the following: pH, P and K. As a result, these soils do not maximise grass production. Nationally, 65% of grassland soils require lime to neutralise soil acidity (i.e. soils with low pH levels). In some counties in excess of 80% of soils require lime. Grassland farmers should aim to maintain mineral soils between pH 6.3 to 6.5 and peaty soils between pH 5.5 to 5.8. This is the first step towards increasing soil fertility and grass production to meet the feed demands of the livestock over the growing season

### What effect does lime have in the soil?

Lime is a soil conditioner and reduces soil acidity by neutralising the acids present, allowing the micro-organisms and earthworms to thrive and break down plant residues, animal manures and organic matter. This helps to make stored soil nutrients such as N, P, K, sulphur (S) and micro-nutrients available for plant uptake. For example, grassland soils receiving regular lime applications have been shown to release up to 80 kg/ha additional N compared to soils with low pH levels (<6.0). Important grassland plant species such as ryegrass and clover will persist for longer following reseedling where soil pH has been maintained close to target levels through regular lime applications.

## Effect of lime on soil fertility and grass production

Recent research from Teagasc, Johnstown Castle demonstrates the importance of lime in relation to soil P availability and the improved efficiency from applied P fertiliser. Figure 1 shows the change in soil test P levels when lime is applied by unlocking stored soil P (purple bar) and increasing the plant utilisation efficiency of freshly applied fertiliser P (green bar) compared to applying high quantities of P fertiliser alone (red bar). This clearly shows that soil pH optimisation is the first step to consider when setting out to building-up soil P levels.



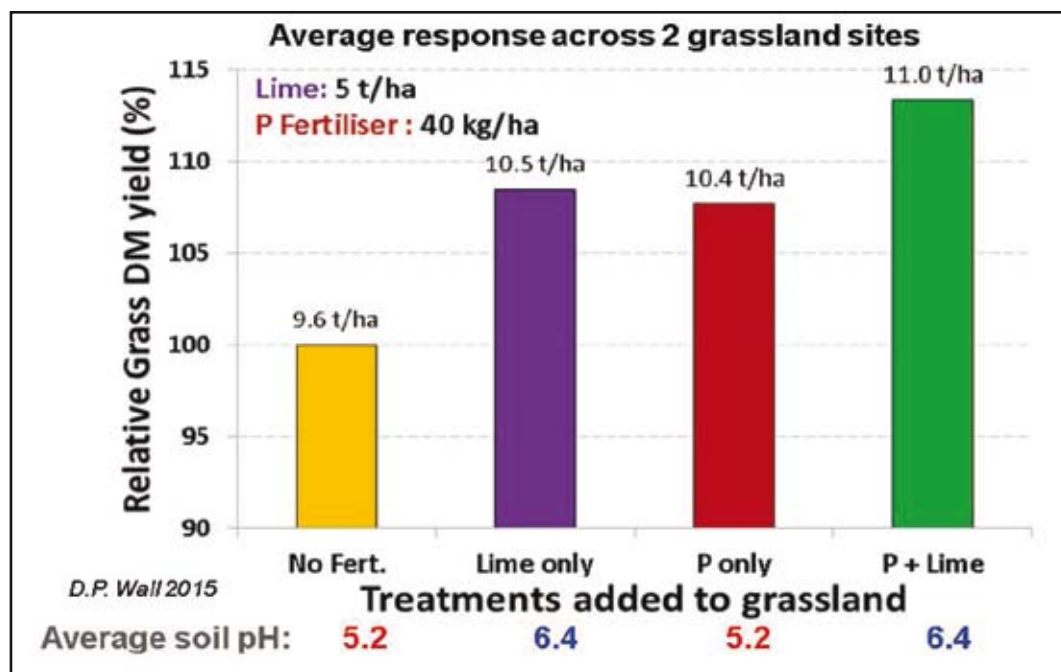
**Figure 1.** Average change in soil test P (Morgan's) across 16 soils (average pH 5.5) treated with Lime (5 t/ha of lime), P fertiliser (100 kg/ha of P), and P + Lime and incubated over 12 months in controlled conditions

Figure 2 shows the grass yield response to lime and P fertiliser in grassland. The application of 5 t/ha ground limestone (purple bar) produced approximately 1 t DM/ha additional grass and had similar grass yields compared to the application of 40 kg/ha P fertiliser alone (red bar). However, the addition of lime + P fertiliser in combination (green bar) produced the largest grass yield response (1.5 t/ha more grass than the control). These results show how effective lime is for increasing the availability of both stored soil P (from previous fertiliser and manure applications) and freshly applied fertiliser P.

## Return on investment in lime

As with any business, achieving a positive return on investment is critical when using inputs. When the pH of grassland soils are maintained close to the optimum range increased grass production of at least 1.0 t DM/ha/year can be achieved. In addition to P and K release from

the soil, increased N supply worth up to €80 may also be achieved, boosting spring growth in particular. If this extra grass production is utilised by grazing livestock it has the potential to reduce farm feed bills by at least €150/ha/year. One tonne of additional grass production each year over a typical 5 year liming period (5 t/ha lime applied) represents a 6:1 (grass €150/t: lime €25/t) return on investment in lime application, not including the potential for reducing fertiliser costs into the future.



**Figure 2.** Relative grass DM yield response in grassland treated with Lime (5 t/ha of lime), P fertiliser (40 kg/ha of P), and P + Lime over a full growing season

## Management tips when applying lime to grassland

- Apply lime based on the soil test report. Where lime recommendations exceed 7.5 t/ha it is best to split the total application rate and apply up to 7.5 t/ha initially and the remainder in year 3.
- Lime can be applied at any time of the year; however, mid-summer and autumn are ideal as soils are dryer and firm.
- Ground limestone is the most cost-effective source of lime. Ground limestone will start to work once it is applied and is washed into the soil. The finer fractions of the ground limestone will adjust soil pH upwards to target soil pH over the shorter term (pH increases should begin within 3 months), while the coarser components will maintain this pH adjustment over the longer term (12 to 36 month period).
- Use magnesium (Mg) limestone where soil Mg levels are low in order to replenish soil Mg reserves.

- Granulated limes are a finely ground limestone (<0.1mm) aiding the reaction with soil acidity to increase soil pH in the shorter term. Recent research shows that these products (usually used at much lower application rates than ground limestone) are more suitable for maintaining soil pH (i.e. where soil pH is close to the target i.e. > 5.9) rather than increasing soil pH substantially.
- Maintaining soil pH will result in increased release of soil N from organic matter up to a value of €80/ha/year. This N release usually occurs in spring and contributes to better early season growth facilitating earlier turnout of livestock to pasture.
- On heavier and organic soils there is often hesitance to applying lime for fear of “softening the sod” or increased poaching (due to rapid break down of soil organic matter). On these soils it is best to apply lower application rates of lime (<5 t/ha) on a more regular basis to control soil acidity and to avoid “softening the soil”.
- It is recommended to leave at least 3 months between liming and application of urea/slurry to reduce the risk of ammonia-N gas loss through volatilization. To avoid such losses occurring, apply urea/slurry first and apply lime 10 days later.
- On grassland soils with high molybdenum (Mo) levels, increasing soil pH above 6.2 can lead to increased Mo levels in herbage. High intakes of Mo in ruminant animals can lead to an increased risk of copper deficiency. It is therefore recommended to maintain soil pH at 6.2 on these soils or consider supplementing animals with copper.





## Making best use of cattle slurry

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### Summary

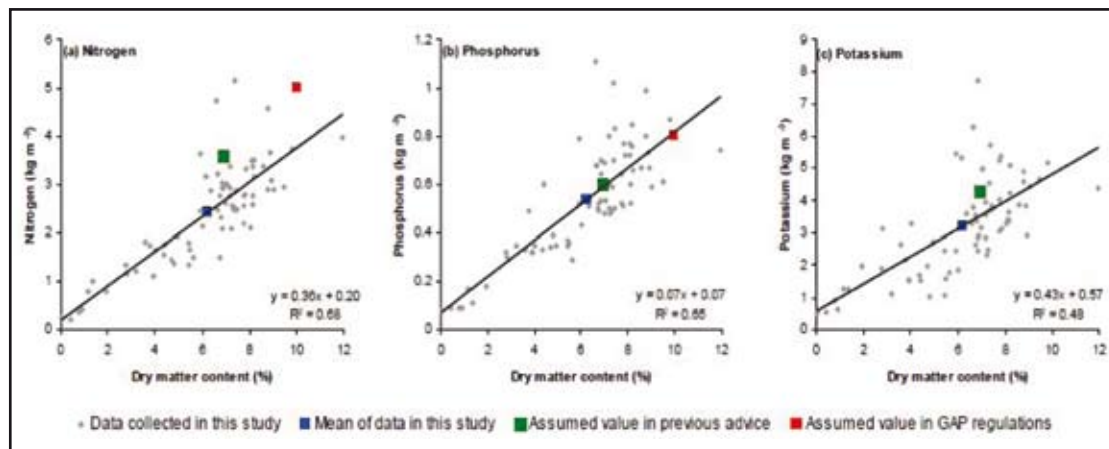
- Slurry is a valuable source of nitrogen (N), phosphorus (P) and potassium (K).
- Target slurry application to areas of the farm with large P & K demands based on soil test results.
- Apply slurry on cool, overcast days in springtime to maximise N recovery.
- Switching slurry application with splashplate, from summer to spring, will increase N value by approximately 3 units per 1,000 gallons.
- Using band spreader or trailing shoe application methods compared to splashplate will also increase N value by approximately 3 units per 1,000 gallons.
- The TAMSII scheme provides support for purchase of low emission spreading equipment.

### Introduction

Slurry is a valuable source of nitrogen (N), phosphorus (P) and potassium (K) and its effective use can help reduce fertiliser costs. To maximise the nutrient value of cattle slurry a number of decisions should be made as to where on the farm slurry is required and consider application method and timing to maximise the N recovery. Spring application of cattle slurry is favourable for efficient use of slurry N. Target fields which soil test results indicate need P and K. One thousand gallons of cattle slurry applied by splashplate in springtime has an available N-P-K content equivalent to a 50 kg bag of 6-5-30. However, the nutrient content of cattle slurry varies with animal type and diet, and especially with the dilution effect of water. Knowing the nutrient content will help ensure that crops receive the planned levels of N, P and K to maximise grass growth for either silage or grazing. Laboratory analysis of slurry helps to estimate the nutrient values for different slurries on the farm. However, in practice this is rarely done. A more practical approach may be to estimate the slurry dry matter on-farm using a slurry hydrometer. Research, summarised in Figure 1, has shown that the dry matter content of slurry is positively correlated with slurry N, P and K content.

### Phosphorus and potassium

Cattle slurry is a good source of P and K fertiliser and should be applied to parts of the farm that have either low soil P or K levels, or to crops with high P and K demands such as grass/maize silage. Targeting these areas will help reduce fertiliser bills and replenish soil P and K reserves. Research shows that fields around the farmyard tend to have higher levels of both P and K due to more regular applications of manures. Silage fields are often the furthest fields away from the yard and tend to have low soil fertility levels plus the largest demand for both P and K. Slurry is a valuable fertiliser and the extra transport costs in moving slurry to fields further from the farm may offset the extra spreading charges associated with extra transport. Slurry is also a very well-balanced fertilizer (P to K ratio) for grass silage crops. For grazing ground, the P and K demand will be lower and will depend on the stocking rate and the soil test results.



**Figure 1.** Relationship between slurry dry matter and nitrogen (a), phosphorus (b) and potassium (c) in 75 slurry samples collected on farms. Values assumed in previous nutrient advice are also shown.

The P in organic manures such as cattle slurry is 100% available relative to chemical fertiliser at soil P index 3 and 4. However, if a soil is P Index 1 or 2 the availability of the P is deemed to be 50%. A soil test will confirm the P status of the soil and help with targeting slurry to Index 1 and 2 soils for soil P index build up to the target Index of 3.

## Reduction in slurry potassium value

Recent research evaluating the nutrient content in cattle slurries has shown that the level of K in slurry (Table 1) is approximately 25% lower than levels that were previously assumed based on older studies from the early 1990s. This reduction in K content is not surprising given the decline in K fertiliser inputs over the same period.

## Nitrogen content

The form of N in cattle slurry is ammonium-N. Ammonium-N is readily available for plant uptake. The ammonium-N in slurry can be lost as ammonia-N gas particularly under drying conditions such as warm, sunny and windy days. To minimise ammonia-N loss and keep the maximum amount of N for plant uptake, aim to apply slurry on cool, overcast or misty days and/or use low-emissions spreading such as trailing hose or trailing shoe. It is recommended to apply as much slurry as possible in the springtime to maximise the fertiliser N value of slurry. Slurry applied in spring is worth approximately 3 units of N per 1,000 gallons (equivalent to about €1.50 per 1,000 gallons) extra compared with summer application, due to better N recovery at that time of the year (Table 1).

**Table 1.** Typical available nitrogen (N), phosphorus (P) and potassium (K) values (kg/m<sup>3</sup>) for cattle slurry

Time of application	N - kg/m <sup>3</sup> (units/1,000 gal)	P - kg/m <sup>3</sup> (units/1,000 gal)	K - kg/m <sup>3</sup> (units/1,000 gal)	€/m <sup>3</sup> (€/1,000 gal)
Spring	0.7 (6)	0.6 (5)	3.3 (30)	€4.6 (21)
Summer	0.3 (3)	0.6 (5)	3.3 (30)	€4.3 (19.50)

Lower dry matter slurry will improve the N uptake as the slurry will infiltrate faster into the soil compared to thick slurry. Lower dry matter slurry will also be washed off the grass faster resulting in reduced grass contamination. It is important to remember that dilution will increase the N efficiency but will reduce the P and K content of the slurry and this needs to be accounted for in balancing crops P and K requirements. Many farmers have seen the benefits of diluting cattle slurry with pig slurry rather than water. The available N-P-K value of 70:30 and 50:50 mixtures of cattle and pig slurry are as shown in Table 2. Before importing pig slurry check your farm fertiliser plan to determine the volume that can be imported onto the whole farm. Importing pig slurry is not permitted on farms with a Nitrates Derogation.

**Table 2.** Typical N, P & K values kg/m<sup>3</sup> for cattle slurry when diluted with pig slurry at different ratio's

<b>Dilution</b>	<b>N kg/m<sup>3</sup> (units/1,000gal)</b>	<b>P kg/m<sup>3</sup> (units/1,000gal)</b>	<b>K kg/m<sup>3</sup> (units/1,000gal)</b>
70% Cattle 30% Pig	1.1(10)	0.65 (6)	3.0 (27)
50% Cattle 50% Pig	1.3 (12)	0.7 (6)	2.4 (22)

## Slurry application equipment

The method of slurry application (splashplate or trailing shoe/band spreader) will have a large effect on N losses. The splashplate technique broadcasts slurry across the full spread width and, depending on timing / weather conditions, high levels of ammonia-N loss may occur as a result. Lower emission systems such as the trailing shoe/band spreader places the slurry in a narrow band close to the soil surface/below the grass canopy and thus, reduce the risk of N loss. Other benefits include, a wider window of opportunity for application in better soil conditions, improved flexibility with application as a result of reduced contamination of herbage leading to quicker return to grazing and the opportunity to apply slurry onto swards with larger grass covers. The odours released during and after application are also usually reduced with trailing shoe or bandspreader compared with splashplate.

Investment by an individual farmer in a trailing shoe or bandspreader may be cost prohibitive as the savings in N fertiliser may not cover the extra costs associated with farmer-owned equipment. This will depend on the volume of slurry on-farm, and the value placed on potential other benefits such as flexibility of timing onto swards with greater pre-grazing sward heights, and reduced odours. However, where a farmer is already using a contractor for applying slurry by splashplate, using a contractor with a bandspreader, trailing shoe or shallow injector may be cost-effective. The contractor price is usually higher per hour, but the value of slurry is increased by approximately €1.50 per 1,000 gallons by these methods, so depending on the volume spread per hour, a higher cost per hour of the contractor can often be justified for using lower emission techniques.

## Targeted Agricultural Modernization Scheme – TAMS II

There have been in excess of 450 applications to date to the Low Emissions Slurry Spreading (LESS). LESS provides grant aid to farmers for the purchase of slurry tankers and umbilical system, using one of following attachments (trailing shoe, shallow injection and dribble bar)

- In the case of an individual applicant or company, the maximum grant amount payable is 40% on costs up to the ceiling of €40,000.
- In the case of DAFM-registered partnerships, the maximum grant amount payable for two or more eligible partners is 40% on costs up to the ceiling of €60,000.
- Eligible young farmers can avail of grant aid of 60%.

The minimum amount of investment, which is eligible for approval under this Scheme, is €5,000 per application. Grant aid will not be paid for second-hand materials or equipment. Grant aid is only available for the purchase of a slurry tanker or umbilical slurry spreading system if it includes one of the following spreaders: a) dribble bar (or band spreader), b) shallow injection attachment or, c) trailing shoe (or trailing foot). An application is ineligible if one of the spreaders listed above is not purchased. A slurry tanker must have a spreader fitted and cannot be fitted with a rain gun. An existing tanker can only be retrofitted with a dribble bar spreader.

## Key points to know about the TAMS II Scheme:

- 60% grant aid for young farmers;
- 40% grant aid for all other schemes;
- Compulsory ranking and selection of all applications;
- Applications must use standard DAFM costings for each investment;
- Applicants have three years to complete the project applied for;
- Only one application accepted per tranche;
- Applicants must have submitted a Basic Payment Scheme application prior to applying for TAMS II;
- Applicants who apply for animal housing and/or nutrient storage must have the required 16/18/20/22 weeks' storage;
- Applicants found to be in non-compliance with nitrates slurry storage requirements will not be eligible for grant aid and the DAFM may issue penalties or sanctions;
- Applicants must complete a Health and Safety course; and,
- Payment is based on the lower of either of the approved or completed reference cost or receipted cost.

## Water quality and sustainability

*Ger Shortle<sup>1</sup>, Per-Erik Mellander<sup>1</sup> and Tom O'Connell<sup>2</sup>*

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### Summary

- Achieving sustainable production can deliver significant gains on Irish farms.
- Protecting and maintaining water quality is a key component of sustainability.
- Good sustainability credentials enhance the value of food products.
- Ireland's water quality is among the best in Europe.
- Protecting water quality can deliver a win/win for farmers.

### Introduction

By developing truly sustainable systems of production the Irish beef sector has an opportunity to capitalise on our clean environment and increase the value of our products. Protecting and improving water quality is at the core of this challenge.

### What is sustainable beef farming?

There are many definitions of sustainability but sustainable beef farming may be described as the efficient production of safe, high quality beef, in a way that protects and improves the natural environment, safeguards the health and welfare of the cattle and provides for the social and economic needs of the farming community.

To be truly sustainable a beef farm must be capable of being handed on to the next generation in as good or better physical, financial and environmental shape as it is now. In the current difficult financial climate beef farmers may be forgiven for not recognising the importance of sustainability but it's now more important than ever that beef is produced in a way that protects the environment and ensures high animal welfare. The negative effects of environmentally unsustainable farming more than outweigh any short-term saving that might be gained.

### Sustainability has a market value

Sustainability is one of the biggest worldwide trends in food marketing and therefore it has a substantial value in the marketplace. While beef processors and retailers around the world all like to attach sustainability claims to their products, not all of them can do it in a transparent and verifiable way. Ireland has a major marketing advantage in this regard, which has been recognised by Bord Bia and incorporated into their marketing strategy in the Origin Green initiative. This is the first sustainability programme in the world that operates on a national scale, bringing together government agencies, the private sector and farmers. To date, over 45,000 Irish beef farms have been audited, accounting for over 90% of our total beef production.

Importantly Origin Green includes an inspection and verification requirement, with sustainability targets for farmers and processors. By moving towards achieving these targets the beef sector can reduce environmental impacts and protect Ireland's extraordinarily rich



natural resources. Our grass-based beef production system gives Ireland a strong foundation in sustainable production.

## Water quality in Ireland

The quality of Irish groundwater and surface waters are among the best in Europe. However, the EPA water status assessment for 2010-2012 shows that 48% of rivers, 57% of lakes, 55% of estuaries and 4% coastal waters (by area) assessed were impacted to some degree. Only 1% of groundwater bodies are at poor chemical status due to high phosphorus levels or due to historical contamination from mining activities and industrial development. Elevated nitrogen and phosphorus levels continue to be the most widespread surface water quality problem in Ireland. The EPA associates these elevated nitrogen and phosphorus levels primarily with human activities, such as agriculture and wastewater discharges to water from towns, villages and septic tanks in rural areas (see Table 1).

**Table 1.** Summary of Water Framework Directive (WFD) water status for groundwater (chemical status) and surface waters (ecological status) during 2010-2012. (EPA, 2015)

Status of Irish waters (2010-2012)	High	Good	Moderate	Poor	Bad
Groundwater(% area)	n/a	99	n/a	1	n/a
Rivers (% water bodies)	11.8	41.0	28.6	17.9	0.7
Lakes (% water bodies)	11	32	33	15	9
Transitional(% area)	3.6	41.1	43.4	11.4	0.5
Coastal (% area)	63.4	30	4.4	<0.01	0.0

Trends in river water quality since the last reporting period (2007-2009) show a decline in waters with bad and poor status and a small increase in combined high and good status. Moderate status waters increased slightly. So the picture is one of overall slow positive trends but with a substantial amount of ground to make up.

## Rules and regulations

The Nitrates Directive is one of the key EU laws for the protection of waters against agricultural pressures. In 2006 Ireland's National Action Programme under the Nitrates Directive was introduced. It brought into force the Good Agricultural Practice (GAP) measures which are generally known as the "Nitrates Regulations". Since then farmers have been living with the regulations and are subject to inspections and potential penalties if there are any breaches of the GAP measures.

The Nitrates Directive is one of a group of directives that have been brought together in the Water Framework Directive (WFD). This Directive is unique in that, for the first time, it establishes a framework for the protection of all waters including rivers, lakes, estuaries, coastal waters and groundwater, and their dependent wildlife/habitats under one piece of environmental legislation. While the Nitrates Directive focusses mainly on achieving good chemical status for water, the WFD is primarily concerned with bringing waters to at least good ecological status.

Specifically the WFD aims to:

- protect/enhance all waters (surface, ground and coastal waters);
- maintain existing "high status" waters;
- achieve "good status" for all waters;
- manage water bodies based on river basins or catchments; and,
- involve the public in this process.

## Protecting water quality on beef farms

Farmers have two strong incentives to encourage them to work towards better water quality; market demand for sustainably produced food and regulations. However, there is a third and probably more important incentive; improved production efficiency. Many actions that a farmer can take to reduce the risk to water quality will also have the effect of improving economic performance i.e. a win/win for the farmer. The most important of these are listed below:

1. *Improved nutrient management planning* – this is the single area with the greatest potential to improve outcomes for water quality on Irish farms. Better management of nutrients, including liming to correct soil pH, will optimise nutrient use efficiency and deliver better profits for the farmer, while reducing risk of nutrient loss to water. An enhanced approach to supporting farmer nutrient management decisions is one of the elements needed to achieve this improvement. The new Teagasc Nutrient Management Planning (NMP) Online package aims to address this need by making it easier for advisers and planners to produce high quality NMP's with maps that make it easier for the farmer to understand and implement the plan. Of course specialist advisory support to interpret the plans is also important and more information on this can be got from your local Teagasc office.
2. *Better slurry-spreading decisions* – generally farmers are pretty good at deciding where, when and how much slurry or dung to spread. This is backed up by recent research from the Agricultural Catchments Programme, which found that there was little evidence of slurry in streams following the end of the 'closed period' for slurry spreading. This means that farmers either weren't spreading slurry or farmyard manure at this time, or were spreading it on the parts of their farms where it was less likely to be washed off. There were, however, some signals of slurry in runoff at the start of the closed period. This occurred when early autumn storms quickly followed the last few days of the 'open period'. These signals were also found during the particularly wet summer of 2012 when soils were wet and storms coincided with normal summer slurry spreading. Farmers can reduce the risk of slurry run-off by targeting slurry spreading in the growing season, while keeping an eye on the weather forecast to avoid wet ground conditions and spreading well before the start of the closed period. In future it may be possible to have real-time updates on expected ground conditions for farmers based on weather forecasts to support their decision making.
3. *Eliminating point sources* – point sources is the term used to describe sources of nutrient other than those lost off the land through run-off. These are divided into agricultural sources (what escapes from farmyards, milking parlours, silage pits, effluent tanks etc.) and non-agricultural sources (mainly septic tanks). The impact of farm and non-farm point sources can be significant and where there is evidence of this impact, targeting and elimination of these sources will reduce pressure on the receiving waters and leave more 'head-room' for losses from farming. The Agricultural Catchments Programme has found

that point sources can have a disproportionately large negative impact on stream-water quality during the summer. In some catchments summer phosphorus concentrations in streams increase as the water level reduces, indicating that it's mainly a point source influence since in summer losses by run-off from land don't generally happen. This may have a disproportionately large impact on year-round stream ecology as streams generally don't recover from the damage suffered during the summer and the cycle is repeated from year to year.

4. *Reducing sediment losses* – Irish sediment losses are low by international standards. Stream bank and bed erosion and road losses make up most (75% in a poorly drained catchment) on the more common land uses, i.e. grassland in catchments with modified channels. This sediment can cause significant damage to the stream ecology either directly by clogging up gravel beds or indirectly by carrying phosphorus which binds to the particles of sediment into the stream. Farmers can reduce the risk of sediment loss by some simple measures like: taking care to avoid siting field gaps, troughs and feeders near streams; directing run-off from roads away from streams or drains; and, reducing cattle access, especially where stream banks are likely to collapse.
5. *Improving production efficiency* – most improvements in farm management, such as better animal breeding or better grassland management, will lead to better nutrient use efficiency as more product is produced from lower inputs. This means that the farmer gains, either through lower input costs or having more liveweight to sell. Consequently, more of the nutrients that are imported onto the farm in feed and fertiliser are exported back out again in the animals that are sold. Thus, better farm management practices, while not directly targeting environmental gains, will likely have positive environmental and economic effects – a classic win/win.

## Ongoing Teagasc Research

Teagasc has a substantial research programme focussed on farming and water quality. The largest single part of this is the **Agricultural Catchments Programme** which is funded by the DAFM. In Phase 3 of this programme (2016 – 2019) it is planned to build on the data collected and the work done in the previous two phases by continuing with the current approach, while developing a greater capability to model the future impact of farming on water quality. **Harmony** is another DAFM-funded research project examining nutrient management strategies in high status catchments. The Harmony project aims to integrate agri-environmental research with socio-economic tools to provide evidence-based measures for nutrient management that are cost-effective and acceptable to the farming community.



## Ireland's green credentials: the role of farmland habitats and GLAS

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### Summary

- Marketing of Irish beef is largely based on our 'green' environmental image.
- Sustainability includes biodiversity – there is increasing pressure from multi-national and national agri-food companies to include farmland habitats in sustainability assessments.
- Irish farming systems have a competitive advantage in the prevalence of farmland habitats.
- Farmers are encouraged to maintain and appropriately manage existing farmland habitats.
- Joining the agri-environment scheme GLAS is worth consideration by beef farmers.

### Introduction

Food Wise 2025 emphasises Ireland's reputation for green, sustainable production as a key opportunity for the agri-food sector. The mapping of farmland habitats is a key requirement of international sustainability assessments as part of accreditation schemes. As part of the E-ruminant project, Teagasc has been working on the development of methods to map farmland habitats in a cost-effective manner, which could reduce the costs and effort of preparing farmland habitat maps.

Compared to international farming systems, the Irish countryside hosts a considerable diversity of farmland habitats and biodiversity that includes: hedgerows, watercourses, field margins and species-rich grasslands; native Irish flora (trees, flowering plants, ferns, mosses and lichens); and, native Irish fauna (birds, bats, amphibians, fish and invertebrates). Irish farmers generally have a competitive advantage, with relatively high areas of farmland habitat compared to international comparisons. However, there is no room for complacency. For example, one third of the 98 wild bee species in Ireland are known to be threatened with extinction.

### Management of farmland habitats on beef farms

Farmers' actions play a key role in wildlife issues. It is most important to maintain and appropriately manage *existing* natural habitats. This is also a key requirement of international accreditation schemes for sustainability. Furthermore, there are opportunities to rejuvenate existing habitats and create new habitats on beef farms.

#### 1. Leave a whitethorn tree in every hedge

Allow individual whitethorn trees mature and flower within every routinely trimmed hedgerows to provide pollen from flowers for bees and other insects and provide haws as food for birds.

## *2. Allow routinely trimmed hedgerows grow taller*

Birds nest in hedgerows over 1.4 metres high which provide cover from ground and overhead predators. Side-trim hedges to a triangular shape from a wider base, with the peak cut to prevent the hedges escaping into individual mature trees. A diversity of hedgerow types on each farm is ideal with some routinely trimmed and others allowed grow into mature relict hedgerows, which are side-trimmed only.

## *3. Clean watercourses in an environmentally friendly way*

When cleaning a channel, remove vegetation and silt material from the open channel only. Do not remove stone or gravel. Place spoil along the bank outside the bank-full line, spreading thinly. Retain bank slopes intact with a margin of vegetation. Leave a buffer length of 20 m at the downstream end of a drain discharging in to a river to act as a silt trap. For least disruption to fish, plan work during July to September. Fish and their spawning grounds are protected under the Fisheries Acts (1959 – 2010). In-stream works should not be carried out without prior consultation and approval of Inland Fisheries Ireland ([www.fisheriesireland.ie](http://www.fisheriesireland.ie)).

## *4. Replace drinking points with an alternative water supply*

Replace drinking points with piped water. Where piped water is not available, consider installing a nose pump. Access by livestock to watercourses even to a well-managed drinking point destroys vegetation, causes siltation which clogs up gravel. Fencing and providing alternative supplies of water prevents fouling with pathogens and prevents the escape of Nitrogen and Phosphorus to water.

## *5. Allow birds and bats nest in buildings*

Swallows return from Africa to the same farmyard each year. Never interfere with existing bird nests or bat roosts. Any renovation works or disturbance should be undertaken outside the breeding season. Do not block entrances to buildings where birds are nesting or bats are roosting. Create new entrance holes and access points to older and derelict buildings to make them more accessible. Erect nest boxes for birds and bat boxes inside or outside farm buildings. Take care when using rodenticides – follow CRRU (Campaign for Responsible Rodenticide Use) code: [www.thinkwildlife.org](http://www.thinkwildlife.org).

## *6. Identify and control invasive species*

Invasive plant species such as Japanese knotweed, Giant hogweed and Himalayan balsam are not native to Ireland and spread rapidly, threatening native species and damaging habitats such as watercourses margins. Prevent their spread to or from your land and control or eradicate if already present. Invasive New Zealand flatworms devour earthworms and impact soil quality. For further information and to report sightings of invasive species: <http://invasives.biodiversityireland.ie>.

## *7. Plant native hedgerows*

Plant 5 whitethorn plants per metre into cultivated ground, in a double staggered row. Include some holly, blackthorn, spindle, guelder rose, and hazel to increase its wildlife value. Prune plants back to 100 mm above ground level to encourage dense growth where required at ground level. Leave an occasional whitethorn unpruned to grow into a tree. Cut a strip of used silage plastic 1.2 metres wide. Push the pruned shoots through the plastic. Retain the plastic with gravel or push the edges into the ground. Fence out rabbits and hares if necessary using two strands of electric wire: 150 mm and 450 mm above ground level.



## 8. *Plant native trees*

Plant bare-rooted two year old whips during the dormant season – avoid exposure to air. There is usually no need to stake whips (large trees do require staking). Place a tree guard around each tree and fence off livestock as necessary. Keep an area of a metre around the tree, weed free. Choose from the twenty or so native Irish tree species (except Ash at present because of Chalara disease).

## 9. *Grow a crop for wildlife*

Growing crops for wildlife and leaving them un-harvested over winter provides seed food through the winter for seed-eating birds. A mix of oats and linseed sown each year is recommended. Cereals suit yellowhammer. Linseed suits finches, linnet and skylark. Crops provide refuge for hares, mice, voles, owls and kestrels.

## 10. *Leave field margins and grassy areas*

Field margins, corners and grassy farm roadways are valuable **provided** fertilisers or sprays are not applied which encourage aggressive plants such as nettles, thistles and docks and that the vegetation is cut after flowering in August every few years. These areas provide space for broad-leaved plants, traditional grasses, beetles, butterflies, bank voles, mice, shrews linnet and meadow pipit.

## **Biodiversity in Teagasc Grange**

In 2014 a farmland habitat survey was carried out at Grange. Farmland habitats including 26 km of hedgerows, 20 km of watercourses and 14 ha of woodland were recorded. Since then, 3,000 m of new whitethorn hedgerow was planted bringing the current level of hedgerow to over 130 m per ha. In addition to the biodiversity benefits, the biosecurity value is increased on the livestock farms.

To complement the existing mature trees already present in the hedgerows, new saplings from within the existing hedgerows have been allowed to grow up. Whitethorn in particular has been chosen and in time will provide flowers for bees and haws for birds within these routinely trimmed hedgerows. Bat and bird surveys are underway to identify the species of birds and bats present on the farm.

## **GLAS (Green, Low Carbon, Agri-Environment Scheme)**

GLAS is the new agri-environment scheme which is part of the Rural Development Programme 2014-2020. GLAS aims to address the cross-cutting objectives of climate change, water quality and biodiversity. There are 38,000 farmers in GLAS 1 and 2 undertaking a wide range of actions involving the maintenance, rejuvenation and creation of farmland habitats. GLAS 3 is expected to open for applications in autumn 2016. GLAS is structured around a hierarchy of tiers. Priority access is given to farmers with Priority Environmental Assets (PEA's) such as commonages, important bird-species, high-status watercourses, NATURA and Rare Breeds. Beef farmers who do not have PEA's can increase their chance of acceptance into GLAS if they undertake to grow one hectare of Wild Bird Cover or use Low Emission Slurry Spreading equipment to spread all their slurry. Joining GLAS is a five year commitment with payments of up to €5,000 per year. Some farmers may qualify for a top up payment of up to €2,000 per year where there are Priority Environmental Assets.



**Figure 1.** 3,000 m of new whitethorn hedgerows have been planted in Teagasc Grange (left). A new whitethorn sapling from within the hedgerow allowed to grow up and in time will provide flowers and fruit for bees and birds (right).

**Table 1.** GLAS 1 and 2 actions: uptake and payment

	Farmers	Units (ha/m/no.)	Payment €/unit		Farmers	Units (ha/m/no.)	Payment €/unit
Low input pasture	27,877	216,187	314/ha	Catch crops	1,371	18,330	155/ha
Hay meadow	9,853	37,757	314/ha	Fallow land	550	1,156	750/m
Wild bird cover	7,467	13,126	900/ha	Arable margins	175	309,818	0.35 - 0.70/m
Bird boxes	11,816	140,493	13/box	Min. tillage	188	6,075	40/ha
Bat boxes	10,124	132,037	6/box	Low emission slurry	2,279		1.20/m <sup>3</sup>
Bee boxes	2,309	10,812	6/box	Natura	5,968	88,596	79/ha
Bee sand	8,527	16,413	45/heap	Commonage	6,551		120/ha
New hedges	7,455	1,268,644	5/m	Chough	615	9,876	365/ha
Coppicing hedges	5,013	2,061,417	2.20/m	Breeding waders	108	993	366/ha
Laying hedges	1,482	465,354	3.70/m	Corncrake	42	65	364/ha
Fencing watercourses	14,208	11,767,409	1.50/m	Geese and swans	1,049	25,863	205/ha
Riparian margins	163	52,560	1.50-3.60/m	Curlew	170	2,320	366/ha
Trees	2,897	1,226,087	0.90/tree	Grey partridge	1,455	73,962	2.10/m
Traditional apple trees	1,260	12,600	23.50/tree	Hen harrier	1,828	362,101	370/ha
Stone walls	5,962	8,857,685	0.70/m	Twite	331 3,037	375/ha	
Archaeology	2,863	4,456	120-146	Rare breeds	763		200/LU



# Technology Village: Grassland

## Reseeding, fertiliser and white clover for beef systems

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### Summary

- Reseeding is one of the most cost-effective on-farm investments.
- With spring reseeding there is no loss in annual grass dry matter (DM) production in the establishment year compared to permanent pasture.
- Management after reseeding is just as important as decisions made at sowing.
- White clover can increase the productivity of beef production systems through increased animal performance and herbage production.
- White clover can be established by reseeding or over-sowing clover into existing swards.
- Excellent grazing management is required for grass-clover swards.

### Introduction

Economically, pastures with a low proportion of perennial ryegrass are costing farmers up to €300/ha per year due to a loss of grass DM production and reduced nitrogen use efficiency during the growing season. If the cost of reseeding is estimated at approximately €700/ha, the increased profitability of the reseeded pasture would cover the reseeding cost in just over 2 years. This means reseeding is one of the most cost-effective on-farm investments. In addition, with increased product price volatility and environmental regulations here to stay, as well as increased nitrogen (N) fertiliser prices, there is increasing interest in the use of white clover (*Trifolium repens* L., hereafter referred to as clover) in perennial ryegrass (*Lolium perenne* L.) swards.

In a perennial ryegrass sward, clover has been shown to increase animal dry matter (DM) intake at grazing which can lead to higher liveweight gain. Additionally, clover has the ability to fix atmospheric N, make it available for grass growth and supply between 50 to 150 kg N/ha per year to the sward. The proportion of clover in swards varies depending on the time of year and sward management. Generally, in grass/clover swards there are low levels of clover in swards in spring (< 10%), and this increases to a peak (of 40-50%) in late summer/early autumn. Clover has a lower growth rate than grass at temperatures below 10°C, which leads to low sward content in spring. Clover growth continues up to 24°C, whereas grass growth peaks at 15-20°C. As a result of their different growth rates, clover and grass growth patterns complement each other with grass growth peaking in May/June followed by a decline, while clover growth peaks in July and August.

### Reseeding methods

Paddock preparation for reseeding is dependent on soil type, amount of underlying stone and machine/contractor availability. There are essentially two methods of preparing the seedbed. The most common method is ploughing. In many areas however this is not possible because



the ground is too stony, soil is too shallow or topography is too steep. Recent technological advances, such as minimal cultivation techniques, enable reseeding to be carried out without ploughing.

Studies undertaken at Teagasc Moorepark in recent years have investigated the effect of reseeding method on grass DM production. Four methods of reseeding were compared, namely; 1) direct drilling, 2) discing followed by one-pass, 3) one-pass with power harrow and 4) ploughing (conventional). One of the main aims of the studies was to evaluate alternative grassland reseeding methods in terms of their effect on grass DM production, sward establishment, and sward persistence. Each of the sward renewal methods evaluated was equally as effective as the conventional method of grassland reseeding. The length of the study (2.5 years) may be too short to fully evaluate the lifetime performance of the swards, but 24 months after establishment, it appears that prevailing grazing management is more likely to influence grass DM production than the reseeding method.

## Timing of reseeding

Most reseeding in Ireland is completed in the autumn. This may make sense from a feed budget perspective but it does have some negative consequences. Conditions deteriorate as autumn progresses – lower soil temperatures can decrease seed germination and variable weather conditions reduce the chance of grazing the new sward. The opportunity to apply a post-emergence spray for weed control is also reduced as ground conditions are often unsuitable for machinery to travel. Therefore, reseeding should be completed as early as possible in the autumn. However, if planning to reseed, the spring period should be considered for at least a proportion of the area.

The effect of timing of reseeding was investigated over a 2 year period. Swards were established in both autumn and spring. The autumn-sown reseed in its first year of production out-yielded an old permanent pasture control sward by 958 kg DM/ha (11,326 versus 10,368 kg DM/ha). In Year 2, this difference increased to 2,410 kg DM/ha (12,749 versus 10,339 kg DM/ha). For the spring-sown reseed there was virtually no difference in grass DM production in the establishment year between the reseeded sward and an old permanent pasture control sward (both swards yielded 9,700 kg DM/ha), whereas in Year 2 there was a difference of 2,033 kg DM/ha in favour of the reseeded swards. A key finding from this study was that there was no loss of grass DM production in the establishment year when reseeding in the spring period. This was due to the new sward being back in production during the main grass growing season, which permitted four grazings to take place post-reseeding in the establishment year. The autumn reseed provided one grazing post-reseeding in the establishment year. These studies indicate that irrespective of timing of reseeding, swards require time to recover after the reseeding process, and to allow perennial ryegrass hierarchy establish. Then the advantage of reseeding becomes apparent.

## Management of reseed

It is vitally important that soil fertility is at recommended levels to ensure high performance from reseeded swards. Prior to reseeding, the old sward should be killed off using glyphosate. When reseeding, ensure that grass varieties from either of the Irish (Republic or Northern) recommended lists are used. These varieties have been tested under Irish conditions. The new Teagasc Pasture Profit Index (Page 170) is also a valuable tool to select the most suitable grass varieties for your farm. Teagasc recommendations are to sow 14 kg seed/acre (35 kg/ha) to ensure good establishment of the sward. It is also advised to sow a minimum of 3 kg of each variety within a mixture.

The best time to control docks and all other weeds is after reseeding. By using a post-emergence spray, seedling weeds can be destroyed before they develop and establish root stocks. The post-emergence spray should be applied approximately 6 weeks after establishment just before the first grazing takes place. Care needs to be taken when grazing newly reseeded swards. The sward should be grazed as soon as the new grass plants roots are strong enough to withstand grazing (i.e. root stays anchored in the ground when the grass is pulled). Early grazing is important to allow light to reach the base of the plant to encourage tillering. Light grazing by animals such as calves, weanlings or sheep is preferred as ground conditions may still be somewhat fragile, depending on the seedbed preparation method used. The first grazing of a new reseed can be completed at a pre-grazing yield of 600 to 1,000 kg DM/ha. Frequent grazing of the reseeds at low pre-grazing yields (<1,400 kg DM/ha or less than 10 cm) during the first year post-establishment will have a beneficial effect on the sward. The aim is to produce a uniform, well-tillered, dense sward. If possible, reseeded swards should not be closed for silage in their first year of production as the shading effect of heavy covers of grass will inhibit tillering of the grass plant resulting in an open sward which is liable to weed ingress.

## Establishment of Clover

There are two ways of introducing clover into the sward – either by incorporating clover in the grass mix (1 - 2 kg) at reseeding or over-sow after a cut of silage. Incorporating clover in a reseed is the best method of establishing clover in a sward as it gives the clover a better chance to establish and also provides the best opportunity for weed control. When reseeding it is best to sow when soil temperature is greater than 8°C and it is important not to sow the clover seed too deep (> 1 cm) as the seed will not germinate. The use of ‘clover safe’ post-emergence sprays is also important after reseeding. This is the best time to kill weeds (i.e. at the seedling stage) in a grass-clover sward as they can be particularly difficult to eradicate after the post-emergence stage. When over-sowing clover into swards, the following guidelines should be followed:

1. *Soil fertility*: Soil pH should be between 6.0 and 6.5, and soil P and K levels should be adequate (target index 3).
2. *Open swards and weed control*: For over-sowing to work, the clover seed has to come in contact with the soil. Therefore, over-sowing will work only where there is a reasonably open sward. For old dense swards and swards heavily infested with broad-leaved weeds, reseeding is a better option. Weeds, especially docks, should be controlled before over-sowing as once the clover is established the range of herbicides that can be used are more expensive and restrictive, as a ‘clover safe’ option must be selected.
3. *Sowing rate and date*: The best time to over-sow is during April and May before the ground gets too dry. Moist soil conditions during and after over-sowing are crucial to success. Apply clover seed with 0:7:30 or similar fertiliser at a rate of around half a bag per acre. Apply 5 kg seed per hectare of a mixture of two clover cultivars. Use medium leafed cultivars in a grazing situation – Iona, Buddy, Chieftain, Crusader, Avoca and Aberherald are recommended.
4. *Broadcasting the mixture*: Seed can be broadcast with fertiliser using a fertiliser spreader or using a slug pellet applicator. Mix the clover seed with the fertiliser in the field. This will avoid the fertiliser and seed separating out while on route to the field. While pouring in the fertiliser, simultaneously mix in the seed to ensure an even mixture of fertiliser and seed.

5. *Post-sowing management:* Apply slurry after over-sowing but reduce the level of N fertiliser after the first few grazings. Nitrogen fertiliser will drive on the grass to the detriment of the clover seedlings. Tight grazing is important. Do not allow covers to get too high (>800 to 1000 kg DM/ha) and graze out to low residuals, i.e. <4 cm. As the clover seedlings get established they will start to fix N (after approximately 8 months) and supply it to the sward.

## Grazing management of grass-clover swards

As with perennial ryegrass swards, excellent grazing management on grass-clover swards is critical in order to optimise both herbage production and nutritive value. Spring can be a particularly challenging time for managing grass-clover swards for a number of reasons. Tight grazing to 3.5 cm is critical to allow light down to the base of the sward to reach the dormant clover plant to promote stolon growth and production. It is important that poaching on grass-clover swards is minimised as poaching will result in a loss of stolons and reduced herbage production. This can be difficult as grass-clover swards can be more open which, combined with softer ground conditions, means grass-clover swards are more susceptible to poaching. Fertiliser N application on grass-clover swards should be similar to grass-only swards in the spring, as the grass-clover swards require N in the spring as much as grass-only swards. Depending on the soil indexes, P and K should also be applied at the appropriate rate to promote clover growth.

Mid-season grazing management of grass-clover swards is similar to that of grass-only swards. Pre-grazing yield should be maintained at 1300-1600 kg DM/ha and swards should be grazed to a post-grazing sward height of 4.0 cm. Rotation length should be between 18 and 24 days during the main grazing season. Nitrogen fertiliser applications should be maintained at similar levels to grass-only swards for April and May. From June onwards, when there is a high level of clover in the sward (> 25%) and it is actively contributing N to the sward, N fertiliser applications may be reduced. In the autumn, it is critical to graze paddocks out well (~4.0 cm) at the final grazing before closing. The loss of stolons over the winter and the fact that clover growth in spring is very slow makes clover very vulnerable to competition from the grass in the sward in early-spring. It is extremely important to graze paddocks out correctly while minimising poaching damage so that light can penetrate to the base of the dormant clover plant to promote stolon survival and production over winter.

## Bloat

Bloat can be an issue in grass-clover swards. Bloat can occur at any time of the year but particular risk times are April/May (due to lush, low DM swards) and from August onwards when sward clover content is highest. Management practices can help to reduce the risk of bloat. There are certain indicators that bloat may occur, these include;

- high clover content (> 60%) in the sward - repeat incidences of bloat can occur in paddocks with consistently high levels of clover,
- weather conditions - high rainfall over a prolonged period leading to lower DM swards, or mornings where there is heavy dew,
- changing from grass-only to grass-clover swards, and
- hungry cattle going into a paddock with high levels of clover.

Grazing management of grass-clover swards should be adapted according to these factors. A routine preventative measure is to add bloat oil to drinking water. Bloat oil can be added either directly to water troughs or dispensed through the water system, usually from June to September.

# On farm grass variety performance and developments in the Pasture Profit Index (PPI)

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## Summary

- On-farm grass variety evaluation is now established on 82 farms nationwide.
- Mean dry matter (DM) production between varieties ranged from 12.0 t DM/ha to 13.3 t DM/ha.
- Long-term DM yield persistence will emerge from this dataset.
- There is a range in Pasture Profit Index (PPI) values between the highest (€210) and lowest (€61) varieties.
- Farmers will have to differentiate between silage and grazing varieties when using the PPI.

## Introduction

Food Wise 2025 has set ambitious production targets for Irish ruminant production systems. It is vital that Ireland maintains its grass-based competitiveness in the pursuit of the growth targets set out for ruminants. There are clear improvements to be made in the areas of grass production and utilisation across livestock enterprises. Current levels of perennial ryegrass proportions within swards are low, as are farm reseeding levels. In 2012, on-farm grass variety evaluation began in Ireland. The objective of this evaluation was to quantify the performance of grass varieties on commercial farms across the country. This development has coincided with the introduction of the Pasture Profit Index (PPI) – which is a total merit economic selection index to facilitate the selection of grass varieties. There is a commonality of approach between the on-farm grass variety evaluation project and the DAFM evaluation protocol; all of the traits selected can be easily measured in grass evaluations, and improvements in each trait can be achieved through more focussed plant breeding.

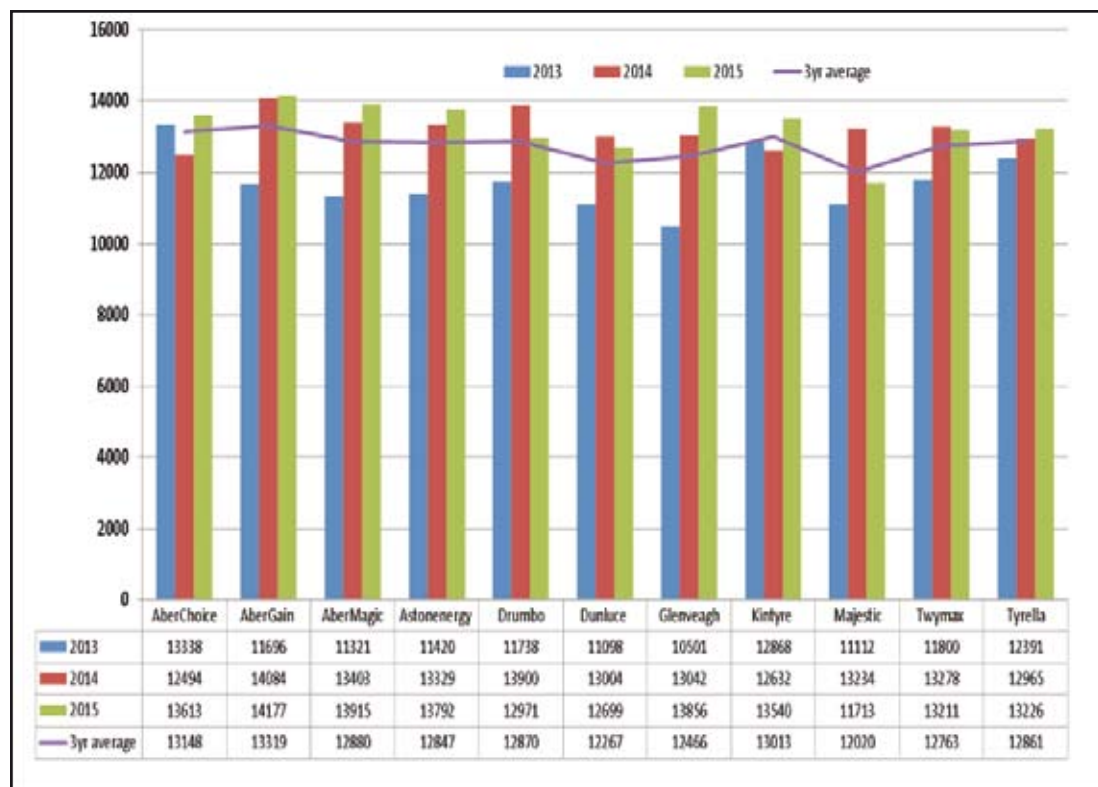
## On-farm variety evaluation

Since 2012, Teagasc Moorepark has investigated the performance of grass varieties on commercial farms; this coincided with the introduction of Pasturebase Ireland (PBI). Since then, on-farm grass evaluation has expanded significantly. The objectives of the study are to:

- 1) investigate the total seasonal grass DM production of grass varieties on commercial farms and to determine their ranking across farms.
- 2) establish if location/environment by variety differences are present in the performance of varieties (e.g. is the ranking of varieties different if sown in contrasting soil-types) and
- 3) establish the long-term DM yield persistence of varieties over five and 10 years.

The number of farms on the project currently, is approximately 82 and this will increase as more farms are recruited from across the country. Counties represented are; Cork, Limerick, Galway, Tipperary, Kerry, Kilkenny, Kildare, Westmeath, Wexford, Roscommon, Donegal, Sligo, Wicklow, Laois, Waterford. It is planned to get a wider representation of farms across other counties to ensure that the island of Ireland is properly characterised. Tryella has been used as the control grass variety across all farms in the first four years. This will change to using AberGain as the control variety from 2016. One of the reasons for changing the control variety is that Tryella is now beginning to fall in economic value in the PPI, while AberGain retains a very high position. A realistic target for this project is to have 80% of PPI listed varieties on farms by 2018. It is envisaged that all new varieties introduced to the Recommended list and PPI list will be sown and evaluated from 2016 onwards. Grass quality (DMD, crude protein) will be measured on a subset of the 80 farms, (approximately 30) from April to September. Sward ground score will be measured annually on all paddocks at the end of the growing season.

The initial three years annual grass DM production data has established Year by Variety differences across the farms and this is shown in Figure 1. There was a difference of 1.3 t DM/ha between varieties across the farms. There were also trends in grass quality differences between varieties; however, more data is required to fully quantify these differences.



**Figure 1.** Dry matter production of grass varieties sown on commercial farms from 2013-2015.



## Pasture Profit Index

The Teagasc Pasture Profit Index (PPI; Table 1) comprises of 6 sub-indices: spring, mid-season and autumn grass DM production, grass quality (April to July, inclusive), first and second cut silage DM production and persistency. The performance of a variety for each trait is calculated by determining the difference between the performance of each variety and the base value

**Table 1.** Teagasc Pasture Profit Index (PPI) 2016

Variety Details			Pasture Profit Index Sub-indices (€ per ha per year)						
Variety	Ploidy	Heading date	Dry Matter Production			Quality	Silage	Persistency	Total €/ha/ year
			Spring	Summer	Autumn				
AberMagic	D	May 31	47	50	63	36	14	0	210
AberGain	T	June 5	38	44	32	65	25	-5	199
Nifty	D	May 27	77	50	49	-6	20	0	190
AberPlentiful	T	June 9	44	51	38	30	14	0	177
Solas*	T	June 10	34	45	51	31	14	0	175
Dunluce	T	May 30	32	42	43	39	23	-5	174
AberChoice	D	June 9	23	47	36	64	8	-5	173
Rosetta	D	May 24	92	25	33	2	16	0	168
Seagoe	T	May 28	33	41	29	20	37	0	160
Kintyre	T	June 7	28	35	47	33	13	0	156
Astonenergy	T	June 2	7	37	31	61	11	0	147
Xenon	T	June 11	22	39	26	46	14	0	147
Magician	T	May 22	53	30	26	7	26	-5	137
Alfonso	T	June 4	13	38	27	51	4	0	133
Aspect	T	June 6	25	41	17	37	9	0	129
Carraig	T	May 24	46	37	23	-11	30	0	125
Navan	T	June 6	10	39	40	26	9	0	124
Solomon	D	May 21	69	29	22	-23	21	0	118
Kerry	D	June 1	34	40	32	0	7	0	113
Delphin	T	June 2	17	40	19	16	20	0	112
Glenroyal	D	June 5	29	40	31	2	7	0	109
Drumbo	D	June 7	26	30	24	44	-5	-11	108
Boyne	D	May 22	54	29	24	-39	39	0	107
Clanrye*	D	June 6	34	42	10	-10	15	0	91
Twymax	T	June 7	-13	44	7	35	16	0	89
Majestic	D	June 2	39	32	33	-16	-1	0	87
Glenveagh	D	June 2	27	35	20	-10	8	0	80
Stefani	D	June 2	21	27	16	-2	8	0	70
Tyrella	D	June 4	40	18	8	3	-1	-5	63
Piccadilly	D	June 3	26	31	12	-23	15	0	61

Ploidy – T – Tetraploid; D – Diploid

for that trait. This is then multiplied by the economic value for that trait, which was calculated using the Moorepark Dairy Systems Model. The economic value assigned to an extra kg of grass DM in spring and autumn is higher than in mid-season because it supports an extended grazing season. The relative emphasis on each trait is as follows: grass DM yield (31%), grass quality (20%), silage yield (15%) and sward persistency (34%). The performance values included in the PPI are based on data collected from the DAFM grass evaluation trials. Varieties are evaluated over a minimum of two separate sowings, with each sowing harvested over two consecutive years after the sowing year. The two harvested years include a 6-cut system involving one spring-grazing cut, followed by two silage cuts and then three grazing cuts; as well as an 8–10 cut system corresponding to normal commercial rotational grazing practice. The PPI index values range from €210 to €61/ha per year for the 30 varieties with data. The sub-indices present the opportunity to select varieties for specific purposes. For example, if selecting a variety for intensive grazing, the focus is placed on seasonal DM yield, quality and persistence with less importance placed on silage performance. If selecting a variety specifically for silage production, then greater emphasis

would be placed on the performance of that variety within the silage sub-index. It is likely, similar to all indexes, that new traits will be developed and incorporated in the future.



## Summary

On-farm grass variety evaluation is now beginning to highlight the differences between varieties in commercial environments. This project is at an early stage but is now delivering very meaningful information. This information will ensure that the Irish grassland industry continually focusses on the selection of varieties with the most economically important traits.



# **Technology Village:**

## **Supporting Beef Systems**

## Agricultural education and training with Teagasc

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### Summary

- Agricultural education is a key consideration for farm families and it is recommended to plan training options in advance of land transfer and succession.
- Family farm income per hectare is between 1.3 and 1.9 times greater for those with a formal education as opposed to those with no formal education.
- Quality and Qualifications Ireland [QQI] Level 6 Specific Purpose Certificate in Farm Administration (Green Cert) is a two-year training programme which covers Animal and Crop Production, Farm Mechanisation and Farm Business Management and Planning.
- QQI Level 6 Advanced Certificate in Agriculture is a specialist two-year programme which covers Dairy Herd Management, Drystock Production, Crops & Machinery and Agricultural Mechanisation.
- The Teagasc Professional Diploma in Dairy Farm Management is a two-year professional work experience programme aimed at those intending to manage a commercial dairy farm.
- Teagasc offer a number of QQI accredited modules/ courses which enable participants to accumulate credits for awards and/or progress to higher education courses.

### Introduction

Education and training is a key consideration for all farmers which will improve the overall technical and financial efficiency of a farm. It is important to select the most suitable educational programme. Adequate time should be allowed to investigate the wide range of agricultural training programmes which are currently available for the land-based sector.

### The economic returns to formal agricultural education

In a recent study '*The Economic Returns to Formal Agricultural Education*' which was published by the Teagasc Rural Economy and Development Programme in 2014, the high rates of economic returns to Teagasc education both at farm level and national level, were highlighted. The study was based on the annual sample of 1,100 farms in the National Farm Survey data for the period 2001 to 2011. Family farm income per hectare was consistently between 1.3 to 1.9 times greater for those with a formal education as opposed to having no formal education. When the wider food supply chain effects of improved agricultural productivity arising from agricultural education was factored in, there was a very high 'social' rate of return of approximately 25%.



## Quality and Qualifications Ireland and the Irish National Framework of Qualifications

Quality and Qualifications Ireland (QQI) has responsibility for validation, quality assurance and certification of all further and higher education and training programmes. The Irish National Framework of Qualifications (NFQ) was established in 2003 and provides a structure or framework, for the Irish qualifications system. The NFQ is a system of 10 levels, based on standards of knowledge, skill and competence. Qualifications achieved in secondary school (SEC), further education and training (QQI) and higher education and training (QQI, the DIT, and the Universities) are all placed on this framework.

### Further Education courses

These courses are suitable for people who wish to develop a career in agriculture, horticulture, equine or forestry. Further Education training programmes are focused on practical skills training in addition to theory-based learning. Many graduates of Further Education courses in agriculture return to farming either in a full-time or part-time capacity. Teagasc offer the following list of QQI Accredited Level 5 and Level 6 courses:

### QQI Level 5 Courses

- Certificate in Agriculture
- Certificate in Horticulture
- Certificate in Horsemanship
- Certificate in Forestry

### QQI Level 6 Advanced Certificate in Agriculture Courses

- Specific Purpose Certificate in Farm Administration (Teagasc 'Green Cert')
- Advanced Certificate in Agriculture (Dairy Herd Management)
- Advanced Certificate in Agriculture (Drystock Management)
- Advanced Certificate in Agriculture (Agricultural Mechanisation)
- Advanced Certificate in Agriculture (Crops & Machinery Management)
- Advanced Certificate in Horsemanship
- Advanced Certificate in Equine Breeding (Stud Management)
- Advanced Certificate in Forestry
- Advanced Certificate in Pig Production
- Advanced Certificate in Poultry Production

### QQI Level 6 Specific Purpose Certificate in Farm Administration-Green Cert

The QQI Level 6 Specific Purpose Certificate in Farm Administration is commonly known as the Teagasc Green Cert. Students must complete the QQI Level 5 Certificate in Agriculture in order to gain entry to the QQI Level 6 Specific Purpose Certificate in Farm Administration. Course content includes; Animal Production Science, Crop Production Science, Farm Business Organisation, Dairy/Beef/Sheep Production, Safe Use of Pesticides, Farm Business Planning, Farm Management and Farm Performance Measurement (including Discussion Group Meetings).

There are 3 modes of delivery available for completion of the Green Cert programme:

1. Full-time: duration 2 years in an agricultural college
2. Part-time: duration 2½ to 3 years approximately in an agricultural college/ local training centre
3. Distance Education\*: duration 18 months approximately in an agricultural college/local training centre

*\*Note: Holders of major awards at Level 6 or higher on the NFQ in a non-agricultural discipline only are eligible to apply for the Distance Education option.*

## QQI Level 6 Advanced Certificate in Agriculture

The QQI Level 6 Advanced Certificate in Agriculture is designed to ensure that participants acquire the high level of technical and managerial skills required to run a commercial farm enterprise. Students must complete the QQI Level 5 Certificate in Agriculture in order to gain entry to the QQI Level 6 Advanced Certificate in Agriculture. They complete a one-year full-time programme including 12-week practical learning period on an approved farm. Students can specialise in dairy herd management, drystock management, crops/machinery management and agricultural mechanisation.

## Higher Education Courses

Higher Education courses are suitable for people who wish to gain a qualification at higher level in the land-based sector. Courses are available in universities and a number of Institutes of Technology. Graduates of higher level programmes may return to farming while others will develop careers in the agricultural services sector. Recruitment to these courses is through the CAO system. There are progression routes from further education into higher education courses.

## Teagasc Professional Diploma in Dairy Farm Management

The Teagasc Professional Diploma in Dairy Farm Management is aimed at those intending to manage a commercial dairy farm as an owner, partner or employed manager. The course consists of two years professional work experience on approved commercial dairy farms, while attending block release periods at Kildalton College and Moorepark Research Centre. Applicants must be holders of a Level 6 Advanced Certificate in Agriculture or equivalent. The programme is validated by UCD.

## Trained Farmer Status

Trained Farmer status for DAFM or Revenue purposes can be achieved by completing an approved course. There are approximately 40 approved/eligible qualifications. In addition, it is preferable for the training to be completed in advance of land transfers/changeover of ownership and management. Table 1 reviews the minimum training requirements for DAFM schemes and Revenue exemptions.

**Table 1.** Summary of Schemes/Exemptions and Minimum Educational Requirements for Trained Farmer status

Schemes/Exemptions	Scheme Education Requirements (Minimum)
<b>Revenue-</b> <ul style="list-style-type: none"> <li>● Stamp Duty Exemption</li> <li>● Agricultural Stock Relief</li> </ul>	QQI Level 6 Specific Purpose Certificate in Farm Administration or *Equivalent Qualification
<b>DAFM-</b> <ul style="list-style-type: none"> <li>● New Entrant to Registered Farm Partnerships</li> <li>● Targeted Agricultural Modernisation Schemes (TAMS)</li> <li>● National Reserve</li> <li>● Young Farmers Scheme</li> </ul>	QQI Level 6 Specific Purpose Certificate in Farm Administration or *Equivalent Qualification

*\*Equivalent Qualification- for example QQI Level 6 Advanced Certificate in Agriculture, Horticulture, Equine or Forestry*

## Life Long Learning and Continuing Education

While QQI Level 5 and Level 6 courses are a foundation for learning, farmers need to continually improve knowledge and skills. As with any career, it is very important to keep up to date with new developments or advances in technology and there are a number of ways to achieve this:

- Formal Training- accredited short courses such as Best Practice in Milking Routine, Managing Ruminant Animal and Managing Crop Nutrition and Health and Safety.
- Informal Training- non-accredited by attending discussion group meetings, open days, conferences.

## College Open Days (October – December 2016)

- |  |                   |
|--|-------------------|
| ● College of Amenity Horticulture, Botanic Gardens | 6th October 2016  |
| ● Gurteen Agricultural College                     | 6th October 2016  |
| ● Ballyhaise Agricultural College                  | 7th October 2016  |
| ● Kildalton Agricultural & Horticultural College   | 7th October 2016  |
| ● Mountbellew Agricultural College                 | 12th October 2016 |
| ● Clonakilty Agricultural College                  | 14th October 2016 |
| ● Pallaskenry Agricultural College                 | 3rd November 2016 |

Further information on all Teagasc courses can be viewed at <http://www.teagasc.ie>

## Best practice for health and safety on beef farms

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### Summary

- Farm accidents and ill health cause tragedy, suffering and long-term disability. They also have the potential to jeopardise a person's capacity to farm effectively and hence jeopardise farm income. Therefore, it is in everyone's best interest to give practical health and safety management adequate attention.
- In 2014 and 2015, respectively, 30 and 18 fatal farm accidents occurred. In 2016, 5 deaths have occurred to the end of May. An estimated 2,500 serious accidents take place each year.
- Farmers have been identified as an occupational group who have a high level of health related mortality. The data available suggests that farmers need to give more attention to maintaining their health, including having regular medical check-ups with their local GP.
- Considerable grant aid support for farm safety improvements is available through the Targeted Agricultural Modernisation Scheme (TAMS 2) up until the end of 2019. Beef farmers need to consider how to make optimum use of this scheme.
- Farmers need to comply with the legal requirements of recently revised standards for agricultural vehicles and trailers used in public roads, and with the sustainable use of pesticides directive.

### Introduction

Farming is one of the most dangerous work sectors in Ireland. Typically about a third of all workplace deaths in Ireland occur in the agriculture sector. In 2014, 30 farm deaths occurred, over 50% of all workplace deaths. In 2015, 18 farm deaths occurred in Ireland, 32% of all workplace deaths. This year, to the 31 May, 5 farm deaths have occurred, with 4 of these involving tractors and machinery. Childhood deaths are particularly tragic and in recent years there has been a significant increase in the occurrence of these fatalities. Farm accidents causing serious injury occur at the high level of approximately 2,500 per year. These can lead to permanent disability and interfere with a person's capacity to farm effectively. Farm accident victim Mr Peter Gohery will be present at Beef 2016 to outline the consequences of an accident he had involving a PTO.

Farmers as an occupational group have been identified as having high levels of preventable ill health. Ill health affects quality of life and more awareness of health promotion practices are needed among the farming community. Teagasc and the Health and Safety Authority operate a Prevention Initiative to assist farmers to effectively manage farm health and safety. This initiative is run in association with the farming organisations represented on the Farm Safety Partnership. At Beef 2016, there will be a Farm Health and Safety Village exhibit to demonstrate how farm health and safety can be improved.

## Legal duty to complete a risk assessment

All workplaces, including farms, have a legal duty under Safety, Health and Welfare at Work (SHWW) legislation to conduct a Risk Assessment to ensure that work is carried out safely. A comprehensive Risk Assessment Document has been prepared for use by farmers and includes a wide-ranging list of possible farm hazards to be considered. The requirement to conduct a Risk Assessment replaced the requirement to prepare a Safety Statement for farms with 3 or less employees, which are estimated to make up about 95% of farms nationally.

Health and Safety Authority staff will be on hand at Beef 2016 to explain the requirements to manage health and safety and to outline the resources available to assist farmers.

## Targeted Agricultural Modernisation Scheme (TAMS 2) 2016-2019.

Grant aid of €675 million is available through the various TAMS Schemes up to 2020. Full details of each scheme are available on the DAFM web site at <http://www.agriculture.gov.ie/farmerschemespayments/tams/>. The principal areas where funding is available include: slurry aeration, access manholes; electrical installations and lighting; livestock handling facilities; safety rails; and sliding doors. It is mandatory that all applicants will have completed, within the last five years prior to the submission of their claim for payment, the half-day Farm Safety Code of Practice course (given by Teagasc or other trained persons) or the FETAC Level 6 Advanced Certificate in Agriculture (Green Cert.). Your claim for payment will not be processed until evidence of completion of the course is provided. It is recommended that you discuss your application with your local Teagasc advisor or agricultural consultant to optimise the benefit for your farm.

A new edition of the booklet '*Build in Safety – An Advisory Booklet for Farmers*', sponsored by FBD Trust, will be launched at Beef 2016. This publication will include a template form for Project Supervisor Construction Stage where a farmer is undertaking construction work, as is legally required under SHWW construction regulations.

## Revised standards for agricultural vehicles

The new revised standards for Agricultural Vehicles, which includes trailers and attached machines, became law on 1 January, 2016. The revised standards are based on recent legislation which updated previous law first introduced in 1963. The purpose of the standards is to enhance the safety of road users. A booklet on the revised standard can be downloaded from the RSA website at <http://www.rsa.ie/en/RSA/Your-Vehicle/Vehicle-Standards/Agricultural-Vehicles/>. Key requirements of the new legislation will be demonstrated at Beef 2016 as follows:

*Braking* – More powerful braking systems will be required for agricultural vehicles operating at speeds in excess of 40 km/h. Where correctly maintained, most of the tractors which have come into use in the past 30 years already meet these requirements. *Lighting and visibility* – Agricultural vehicles will need to be equipped with appropriate lighting systems, flashing amber beacons and reflective markings.

*Weights, dimensions and coupling* – New national weight limits have been introduced. These will enable tractor and trailer combinations which are un-plated to continue in use at limits which are safe for such vehicles. Plated tractors and trailer combinations will benefit from being able to operate at higher weight limits of up to 24 and 34 tonnes for tandem and triaxle agricultural trailers, respectively, provided they meet certain additional requirements. At Beef 2016 a comprehensive exhibit of vehicles and trailers to illustrate the requirements of the new legislation will be provided.



## Sustainable Use of Pesticides Directive

The purpose of the EU Sustainable Use Directive is to put a legislative system in place to ensure that farm pesticides are used responsibly, safely and effectively, while safeguarding the environment. Since November 2015, professional pesticide users (PU) must be registered with the DAFM and have been allocated a PU Number. Farmers are classified as professional pesticide users. In order to register, a farmer must have completed a training course provided by an approved training agency. A list of training agencies is provided on the DAFM web site at <http://www.pcs.agriculture.gov.ie/sud/>. In the event of a DAFM inspection, a farmer will be required to produce evidence of having completed appropriate training.

All boom sprayers greater than 3 meter boom width must be tested at least once by 26 November 2016. The interval between tests must not exceed 5 years until 2025 and 3 years thereafter. A list of approved sprayer testers is available on the DAFM website. At Beef 2016 a practical demonstration of the key issues of effective sprayer operation and use of Protective Equipment will be provided.

## Safety of children on farms

Safety of children and young persons must be paramount on farms. IFA farm family members will be on hand at Beef 2016 to discuss the safety of children on farms. The following precautions need to be considered where children are present on a farm:

*Provide a safe and secure play area for children away from all work activities and in full view of the dwelling house. Where children are not in a secure play area, a high level of adult supervision is needed. Children should not be allowed to access heights. Action should be taken to keep children away from dangerous areas such as slurry tanks. All open water tanks, wells and slurry tanks should be fenced off. Give children clear instruction on farm safety issues. Children to be carried in the tractor cab (aged 7 or older) need to wear a seat belt.*

The renowned safety booklet for children 'Stay Safe with Jesse' by the late Lily Nolan will be available at Beef 2016.

## Preventing Machinery Accidents

Vehicle and Machinery related deaths account for 48% of all farm deaths. With vehicles, being crushed (67%) is the most frequent cause of death followed by overturning (14%), falling from the vehicle (12%), and being struck (7%). With machinery, being crushed (38%) or struck (35%) are the most frequent causes of death followed by PTO (11%) and machine entanglement (11%), and falls from machines (3%). As the data shows that most fatal accidents occur due to being crushed or struck, safety vigilance is especially needed when in proximity to moving vehicles/machines. Entanglement deaths and serious injuries are particularly gruesome and occur most frequently with machines used in a stationary position, such as a vacuum tanker or slurry agitator where contact can occur between the person and the PTO. A range of modern and effective PTO covers will be on display at Beef 2016.

Quads (ATVs) are valuable machines on farms for travel and carrying out certain tasks but they have a high risk of death and serious injury if misused. A FBD Insurance DVD on Safe Quad use on farms will be available at Beef 2016.

## Preventing accidents with cattle

On Irish farms, livestock deaths make up 14% of all deaths and 26% of farm accidents. Cows or heifer accidents account for 50% of livestock-related deaths, with bulls (27%), horses (15%)

and other cattle (8%) accounting for the remainder. A notable trend is that the percentage of cow/heifer incidents causing death has doubled in the last decade, so additional precautions with this livestock group are required. Farmers are advised to keep a bull's temperament under constant review, have a ring and chain fitted, keep a bull in view at all times and always have a means of escape or refuge. Both cow calving pens and bull pens, designed particularly with safety in mind, will be on display at Beef 2016. Breeding for docility will also be considered at the event. A DVD showing safe livestock handling can be viewed at Beef 2016.

## Preventing deaths with slurry

Farm deaths associated with slurry and water account for 10% of farm deaths, with the majority of these being drowning. Particular care is needed when slurry access points are open and physical guarding needs to be put in place. Slurry gases are a lethal hazard on cattle farms. Hydrogen sulphide is released when slurry is agitated and in calm weather it can be present at lethal concentrations. The key preventative measures are to pick a windy day for agitating, evacuate all persons and stock from housing and open all doors and outlets. A range of other gases including methane, ammonia and carbon dioxide can also be released from slurry when agitated, due to fermentation during storage. Never enter a slurry tank as lack of oxygen or the presence of poison gasses could be fatal. Also, never have an ignition source near a slurry tank due to the risk of methane explosion. At Beef 2016, practical means of checking for sufficient air movement will be demonstrated.

## Farmers' health

A major Irish study has indicated that farmers have a 5 times higher 'all cause' death rate than the occupational group with the lowest rate. The major causes where death rates are excessive include cardiovascular disease (CVD), cancers and injuries. A further Irish study indicated that only 59% of farmers had a medical health check with their local GP in the last year compared to 74% for the general population. Among farmers, despite 60% being classified as overweight or obese, just 27% believed that they were too heavy. Lower back pain (LBP) was the most prevalent physical complaint occurring with 28% of farmers. As LBP-associated disability can lead to on-going pain and reduced capacity for physical activity, it has been shown to be associated with other health conditions like CVD. Farmers should reduce risk factors for LBP, like devising farm systems which minimise manual handling (MH) and using the correct techniques for MH. Irish Heart Foundation nurses will be on hand at Beef 2016 to conduct blood pressure checks and provide health-related advice to farmers. Physiotherapists will be available to discuss strategies to manage LBP.

## Further Information

Genuine interest of farmers is key for improving health and safety on Irish farms. New and current information can be downloaded at the following web sites:

Teagasc: [http://www.teagasc.ie/health\\_safety/](http://www.teagasc.ie/health_safety/)

H.S.A.: <http://www.hsa.ie/>

## Notes

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