

Sustainable Grass-Based Production



Dairy BEEF 2019

‘Advancing Knowledge for an Evolving Industry’
Teagasc Crops, Environment and Land Use Research Centre

Johnstown Castle, Co Wexford
Tuesday 21st May, 2019.



AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

Dairy BEEF 2019

Tuesday 21st May, 2019

Compiled and edited by:

Ruth W. Fennell, Donall Fahy, Nicky Byrne and Sean Cummins

*Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford
Teagasc, Moorepark, Animal & Grassland Research and Innovation Programme, Fermoy, Co. Cork
Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath*



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This is a TB restricted farm.

To minimise disease risks and accidents, visitors entering and leaving Johnstown Castle Beef Farm are asked to:

- Use footbaths
- Not handle cattle
- Not enter pens or paddocks containing cattle

Thank You

Open Day Map

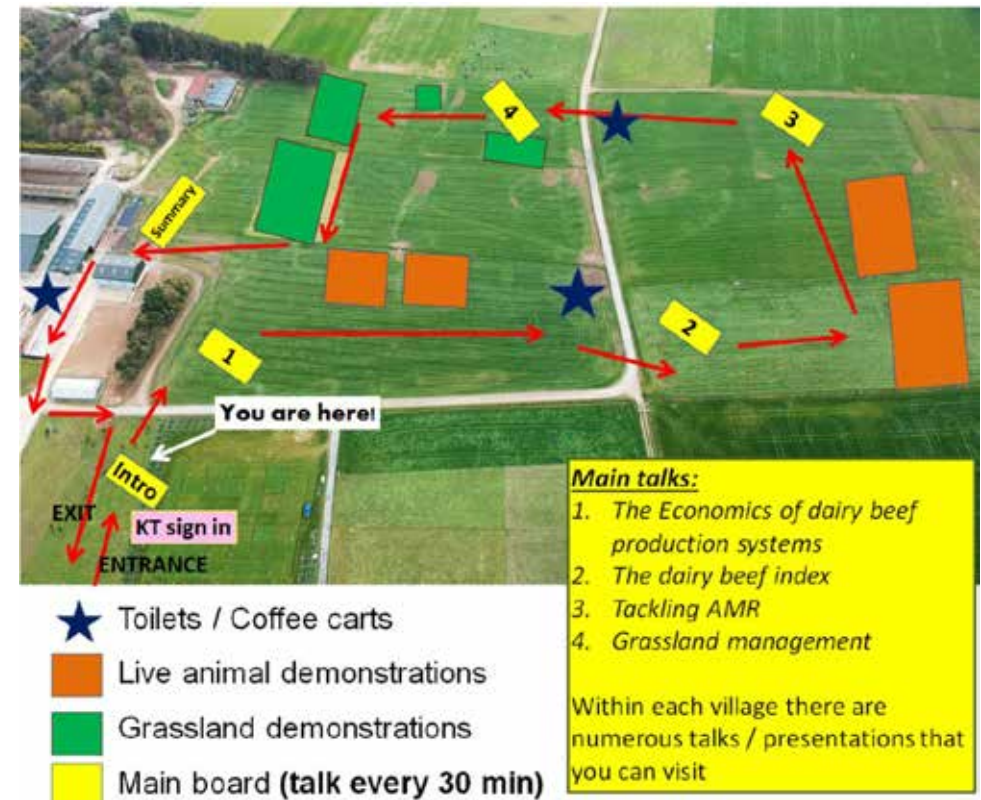


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Foreword

Welcome to the 2019 Dairy Calf to Beef Open Day!

The Irish beef industry is currently facing some very significant challenges, not least from low profitability at farm level and environmental targets to be met from our production systems.

The theme of DairyBEEF 2019 is ‘Advancing Knowledge for an Evolving Industry’, and the dairy calf-to-beef system certainly represents an evolving industry that presents significant opportunities for beef farmers. The number of dairy cows has increased from approximately 1 million in 2010 to 1.5 million in 2019, and there are approximately 1 million dairy male calves and dairy-beef calves now available for beef production. Beef farmers should evaluate dairy-beef production as an opportunity to potentially improve the profitability of their business.

The Irish livestock sector needs to meet stringent environmental targets, which will require increased levels of knowledge and technology adoption. This event features research from the current programme in Teagasc, and Johnstown Castle in particular, to enhance sustainability including; nutrient management, soil fertility, water quality, farmland wildlife, and reduced greenhouse gas emissions.

The open day focuses on the technologies inside the farm gate under the control of the farmer that influence the profitability and sustainability of dairy-beef production systems particularly genetics (including the new Dairy-Beef Index launched earlier this year), grass production and grazing management, and calf nutrition, health and welfare

DairyBEEF 2019 incorporates the dairy-beef production research and sustainable production practices from Johnstown Castle, Grange, Moorepark, Teagasc KT programmes and other stakeholder groups. Teagasc colleagues from Knowledge Transfer, Agricultural Sustainability Support and Advisory Programme (ASSAP) and the Agricultural Catchments Programme are also available today to discuss technologies that you can apply on your farm.

We wish you a day that will be as enjoyable as it is informative, and look forward to continuing the discussions of these topics in the future.

Dr. Padraig French¹ and Dr. John Finn²

¹Head of Livestock Systems Department and Dairy Enterprise Leader

²Johnstown Castle Enterprise Leader



Systems and Economics of Production



Profitable dairy-beef production systems

Padraig French¹ and Richard Lynch²

¹Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

²Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary

- Dairy calf to beef production systems have the potential to be profitable, but these profits are dependent on achieving high animal output from grazed pasture and conserved forage.
- There is a large range of potential systems of dairy beef production varying in age of slaughter and genotype utilising spring born calves which represent over 90% of all dairy bred calves.
- Bull finishing systems can potentially leave very high margins but are very high risk to factors outside the control of the farmer.
- Systems that have a high proportion of grass in the diet and finish animals at a younger age will both increase profitability and reduce environmental footprint.

Introduction

With the national dairy herd already at over 1.5 million cows and growing at approximately 2% per year there is an increasing supply of calves available for rearing and finishing on beef farms. Estimates suggest that there will be over 1.1 million beef and dairy-bred calves available from the dairy herd next year, 2020. In contrast the national suckler herd is predicted to decline over the coming years and has already dropped below 0.9 million cows calving in 2018. Male Holstein-Friesian calves and early maturing (Angus and Hereford) crossbreed calves represent 85% of calves from the dairy herd available for beef production (Figure 1) with late maturing breeds such as Limousin and Belgian Blue accounting for the remainder

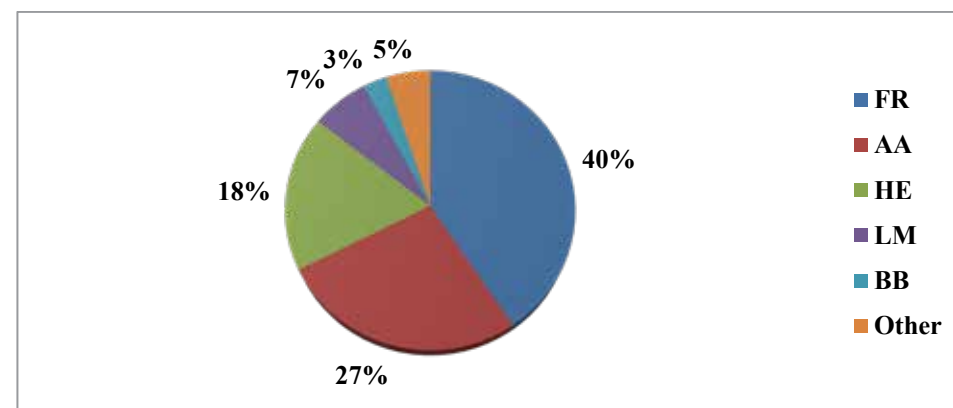


Figure 1. Sire breed profile of calves generated from the dairy herd that are available for beef production (Animal Identification and Movement, 2018).

Dairy-beef systems

Table 1 outlines the outputs and inputs from a range of beef systems from spring born dairy calves. Because of massive improvements in fertility of the national dairy herd, calving usually begins in early February, with most dairy male calves born in the first month of the calving season. The beef cross calves are generally born between March and April, by which time 85% of the national herd has calved.

It is important that a clearly defined system is decided on before any calf is purchased and the key performance targets identified and monitored. While there is a range in profitability between systems, the choice of system on each farm will depend primarily on the resources available, particularly land availability, animal housing and labour. Systems that finish spring born calves before the second winter have a high proportion of grass in the diet and are therefore more resilient to external shocks on beef price and concentrate price, have a lower environmental footprint and generally give higher net margins but require excellent grassland management, good quality winter forage and high lifetime animal performance to achieve carcasses of adequate market specification.

Bull finishing systems can potentially leave very high margins but are very exposed to factors outside the control of the farmer such as beef price and concentrate price and should not be considered without a proper planned finishing system and a secure outlet from a meat processor

Conclusion

The profitability of systems using beef cross dairy calves is very dependent on the animals achieving a minimum carcass specification to ensure they qualify for the quality assurance bonus and any breed bonus available. To ensure this is achieved animals must have the right genetics and be selected for slaughter at an adequately level of finish.



Table 1. Technical and economic performance of dairy calf to beef systems.

	Holstein Friesian				Early maturing			Late maturing	
<u>Production system</u>	15/16 mth bull	21 mth steer	23 mth steer	19 mth heifer	21 mth steer	23 mth steer	24 mth Steer		
<u>Month of birth</u>	February	February	February	Feb/Mar	Feb/Mar	Feb/Mar	Feb/Mar		
<u>Calf price (£/hd)</u>	70	70	70	150	170	170	270		
<u>Slaughter month</u>	May/June	November	February	Sept/Oct	November	Jan/Feb	Feb/Mar		
<u>Feed strategy</u>									
Concentrate during finishing period (duration)	1.6 t (9 mths)	0.33 t (2 mths)	0.44 t (4 mths)	0.15 t (2 mths)	0.21 t (2 mths)	0.5 t (3 mths)	0.5 t (3 mths)		
Grazed grass (%)	15	59	48	51	67	53	54		
Grass silage (%)	22	21	31	33	22	30	29		
Concentrates (%)	63	19	21	16	11	17	17		
<u>Animal performance</u>									
Carcass weight	280	278	305	235	280	315	340		
Carcass grade	O-2+	O-3	O-3+	O+3	O-3	O+3-	R-3-		
Slaughter price (c/kg)	384	373	377	395	382	390	400		
Breed bonus (c/kg)	0	0	0	30	30	30	0		
<u>Farm performance</u>									
Animals finished (ha)	8.6	3.2	2.7	3.9	2.9	2.5	2.4		
Carcass output (kg/ha)	2406	883	827	914	801	797	807		
Costs per kg carcass (c/kg)	370	305	346	344	309	353	370		
Gross margin (£/ha)	1231	1221	946	1486	1331	1186	862		
Net margin (£/ha)	331	565	254	873	729	534	242		
± 20 c/kg slaughter price	± 483	± 139	± 166	± 189	± 128	± 159	± 162		

Assumptions; (i) Farm area 40 ha (ii) 200kg N/ha applied in all systems with exception of 15/16 month FR bull at 130 kg N/ha (iii) Milk powder = €2124/t, (iv) Concentrate = €257/t, (v) Urea = €360/t, CAN = €300/t.

Dairy-beef performance under three stocking rate intensities

Ruth W. Fennell¹, Wayne Hayes¹, Richard Lynch² and Padraig French³

¹Teagasc, Animal & Grassland Research and Innovation Programme, Johnstown Castle, Wexford

²Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

³Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

Summary

- High stocking rate (SR) has a significant effect on carcass weight in heifers and lifetime average daily gain in both heifers and steers.
- Preliminary economic analysis shows higher net margin/ha for medium SR heifer and steer systems.

Introduction

From previous research at Johnstown Castle identified blueprints for alternative dairy-beef production systems. It was found that the most significant factor determining profitability of these production systems was output per ha. With this in mind, the current research programme is evaluating the effects of herbage allowance (by using three stocking rates) on the performance of dairy × beef crossbreed cattle.

Experimental design

Each year 216 reared dairy-beef crossbreed calves are purchased and assigned to one of three SR groups; low (2.65 LU/ha), medium (2.92 LU/ha) and high (3.18 LU/ha). Each group consists of 36 heifers and 36 steers and are balanced for breed (AAX, HEX and LMX). Across the farm, the paddocks are divided in blocks so that the various soil types and conditions are represented in each SR ‘farmlet’. Heifers born in 2015 were slaughtered at either 19 or 21 months of age, while the steers were slaughtered at either 21 or 27 months of age. All animals were finished off grazed pasture and received 2.5 kg of concentrate for 60 days pre-slaughter. From 2016, all animals were selected for slaughter based on a target body condition score of 3.50; the heifers begin their finishing period in August/September and are finished by January. The steers are all housed for the second winter, turned out in the spring and killed off grass in June/July.



Results to date from the stocking rate trial

The average daily gain (ADG) was similar for the high, medium and low SR groups during the first season at pasture, first winter and third season at pasture (steers only). ADG during the second season at pasture (heifers and steers) and the second winter (steers only) was lowest for the high SR animals. Carcass weight was higher in the low and medium SR animals; however this difference was only significant in heifers. Conformation and fat scores and days to slaughter were similar across the three contrasting SR groups for both steers (Table 1) and heifers (Table 2). A preliminary economic analysis compared the 21 month heifer and 26 month steer system across the three stocking rates, assuming a calf price of €200, a finishing period of 60 days on 2.5 kg concentrate/day and a meal price of €257/tonne. From this, the medium stocking density system produced the greatest net margin/ha (Figure 1.)

Table 1. Performance of 2015 and 2016 born steers.

	High	Medium	Low
Average daily gain (kg)			
1 st season at pasture (kg)	0.82	0.81	0.79
1 st winter (kg)	0.60	0.64	0.59
2 nd season at pasture (kg)	0.83	0.94	0.86
2 nd winter (kg.)	0.49	0.60	0.55
3 rd season at pasture (kg)	1.26	1.20	1.16
Lifetime	0.68	0.71	0.70
Carcass weight (kg)	330	339	340
Fat score (1-15)	9.0 (3+)	9.0 (3+)	8.5(3=)
Conformation score (1-15)	5.3 (O=)	5.5 (O=/+)	5.2 (O=)
Days to slaughter	848	848	848

Table 2. Performance of 2015 to 2017 born heifers.

	High	Medium	Low
Average daily gain (kg)			
1 st season at pasture (kg)	0.68	0.73	0.68
1 st winter (kg)	0.64	0.64	0.65
2 nd season at pasture (kg)	0.84	0.90	0.93
Finishing period	1.18	1.16	1.17
Lifetime	0.72	0.74	0.75
Carcass weight (kg)	250	257.5	259
Fat score (1-15)	8.5 (3=)	8.7 (3=/+)	8.7 (3=/+)
Conformation score (1-15)	5.5 (O=)	5.7 (O=/+)	5.7 (O=/+)
Days to slaughter	637	639	637

Table 3. Comparison of carcass output for a 20 ha farmlet (heifers and steers combined).

	Stocking Rate (LU/ha)	Animals/farmlet	Av CW (heifers + steers)	Total Carcass output/ha
High	3.18	74.8	275	1084.6
Medium	2.92	68.7	283	1024.5
Low	2.65	62.4	384	934.4

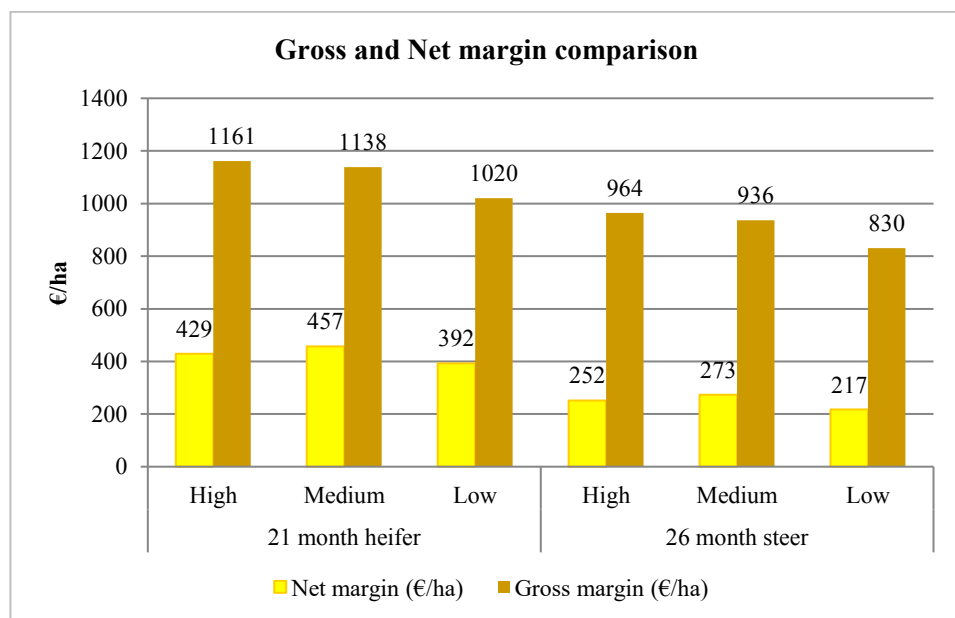


Figure 1. Net margin/ha and gross margin/ha for 21 month heifer and 26 month steer production systems under three stocking rate intensities on a 40 ha farm model.

Conclusion

Significant differences were found in carcass weight, second season ADG and lifetime ADG between the high and reduced SR groups. This is a result of the increase in herbage allowance to the low and medium groups. Although the high SR had greater gross margin/ha, due to increased animal sales and therefore carcass output/ha (Table 3), the medium SR had the highest net margin/ha (Figure 1). Further economic analysis is required to reinforce these results.



Lessons learned from Phase 1 of the Teagasc Green Acres Programme

Gordon Peppard¹ and Pearse Kelly²

¹Teagasc, Kells Road, Co. Kilkenny

²Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary

- The farms improved their average net margin from minus €40 to €475/ha (excluding direct payments) over the three year programme.
- There are many different factors within the control of the farmer that have a large impact on profitability.

Introduction

The Teagasc Green Acres Calf-to-Beef Programme was set up in 2015 to demonstrate profitable dairy calf to beef systems on a whole-farm basis through a network of ten demonstration farms that all had significant calf to beef enterprises. The primary aim of the project was to demonstrate that where a high level of technical efficiency is achieved on beef farms, it is possible to attain a net margin (excluding premia) in excess of €500/ha. The first phase of the programme was completed in March 2018.

10 Key Lessons Learned

1. Have a plan

When purchasing calves, you need to have a plan as to when these animals are going to be slaughtered. If there is no plan in place then there will be implications for housing facilities, slurry storage, silage availability, mixed age groups creating issues for dosing, feeding concentrates for finishing and cash flow.

2. Producing high beef output

This is the kilograms of live weight produced per hectare. It is a combination of a high stocking rate and excellent individual animal performance; targets of 1250 kg live weight/ha should be produced. This can be achieved from a stocking rate of 2.5 LU/ha and a performance of 500 kg live weight per livestock unit. Decide on a production system and stocking rate to suit your land type and housing facilities available.

3. Excellent calf rearing

Source a good quality calf. Buying an earlier born calf (before 17 March) will help increase output. These early-born calves will be weaned and at grass for a longer period in the first grazing season. Feed high levels of milk replacer, ensure good hygiene and be consistent to avoid stressing the young animal.

4. Appropriate calf rearing facilities

Calf housing should be fit for purpose. Ensure a clean, warm, dry, well-ventilated shed for calf rearing. To ensure a dry bed, have a 1:20 slope on the floor from back to front with a channel to remove seepage to an outside tank. Provide plenty of straw to ensure that the

calf is kept warm at all times especially in cold conditions. Pen size should provide 2.2 m² per calf. Ensure that there is no draught at calf level.

5. Animal health plan

Having a health plan in place in conjunction with your vet is essential. With calves coming from numerous sources, having a vaccination programme in place is critical. The top performing farms vaccinate for pneumonia and IBR. A strategic dosing regimen also needs to be planned to control worms, fluke, lice etc. throughout the grazing season and during housing.

6. Correct soil fertility

In order to produce high output from the system, high animal live weight gain from grazed grass is required. To ensure enough high-quality grass is available, soil fertility needs to be at its optimum. First, correct the lime status of the soil and then correct phosphorus (P) and potassium (K) levels to Index 3.

7. Grassland management

Having a paddock system in place to supply quality leafy grass at all times, thereby maximising weight gain from grass, is essential. Aim to have at least 240 days grazing in the second grazing season. To achieve this target, animals need to be turned out to pasture early in the spring. This will require excellent management in the autumn, where paddocks are closed up early to ensure a supply of grass in the spring. Good grazing management in the spring to ensure you set the farm up for maximum productivity over the summer is also critical to success.

8. Produce high-quality silage

Produce high-quality silage to ensure all animals meet the target average daily gain (ADG) of 0.6 kg/day over the first winter period. All silage produced should have a dry matter digestibility (DMD) greater than 70% to help reduce the concentrate level required to meet target daily gains. The financial difference between 62% and 72% DMD silage for 100 weanlings over a 140-day winter could be €7,000 or €70/head.

9. Regular weighing of cattle

To ensure that performance is not compromised at any stage from purchase to slaughter, it is essential that regular weighing of animals takes place throughout the year. At a minimum, animals should be weighed at turn-out to pasture, mid-season and at housing. Poor performing animals should be detected and a remedial action put in place. Animals for finishing can be grouped together, thereby increasing efficiencies as only the stock closest to target weights are fed to slaughter.

10. Review your plan regularly

Having a plan is important, but reviewing it on a regular basis is essential. Are key targets being met? If not, why not? What changes are needed to keep on target or does the plan need to change in some way?

Physical and financial performance

Table 1 outlines the average physical and financial performance across the ten Teagasc Green Acres farms for 2017. There is a huge variation across farms, which is due to a number of factors. All farmers started out with very different levels of profitability and over the course of the programme all improved their margins substantially. There were also a lot of different management styles between farms in a number of the key areas like calf rearing, animal health, grass management, soil fertility and financial/farm planning. Land type and stocking rate also have a huge bearing on profitability.

Table 1. Performance of the ten Teagasc Green Acres farms (2017)

	Average	Minimum	Maximum
Area (ha)	66	26	119
Stocking rate (LU/ha)	2.5	1.85	3.32
Output (kg/ha)	1,293	841	1,845
Gross output (€/ha)	2,424	1,837	3,329
Variable costs (€/ha)	1,366	895	1,768
Gross margin (€/ha)	1,058	566	1,592
Fixed costs (€/ha)	584	331	817
Net margin (€/ha)	475	-32	897

Gross output is the key driver of profitability on the farms. The average gross output across the ten farmers was €2,424/ha, with a range from €1,837 to €3,329. The maximum figure of €3,329/ha clearly shows what is achievable. Gross output has steadily increased throughout the programme.

Average variable costs across all the farms were €1,366/ha in 2017, with a range of €895 to €1,768. The four highest variable costs on the farms were feed, fertiliser, veterinary and contractor. Variable costs increased as output increased over the three years, but at a lower level. The variable costs as a percentage of output decreased from 65% to 56% over the course of the programme. The gross margin increased steadily over the three years, rising from an average of €513 to €1,058/ha. This was driven by the increase in beef output on the farms. The average fixed costs on the farms was €584/ha in 2017. This is very typical of nonbreeding dry stock farms. Fixed costs rose slightly in 2015 to reflect on-farm developments. The aim of the Teagasc Green Acres Calf-to-Beef Programme was to have a net margin of €500/ha excluding all farm subsidies at the end of the programme. Having started with an average net margin of minus €40/ha in 2014, this moved to €136 in 2015, €308 in 2016, and €475 in 2017. This shows that the target is achievable.

Acknowledgments

The authors wish to acknowledge the financial support of Liffey Mills, Drummonds Ltd., Volac Ireland, MSD Animal Health and Grassland Agro. Through this funding a dedicated advisor was appointed to work with the demonstration farms and to disseminate the information that was generated in the programme.



Optimum early-maturing calf-to-beef systems

Robert Prendiville

Teagasc dairy advisor, Clieveragh, Listowel, Co. Kerry

Summary

- Approximately 46% of dairy calves available for beef production are generated from early maturing sires (27% and 19% Angus and Hereford, respectively).
- Spring-born, early-maturing dairy crossbred heifers should be slaughtered before the second winter housing from 19 to 21 months of age.
- Finishing steers off pasture in November or June during their third grazing season was more profitable than indoor winter finishing.

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 approximately 46% (circa 465,000) of dairy calves available for beef production are early-maturing beef/dairy crossbred calves (AIM, 2017). The Angus and Hereford breeds represented 27% and 19% of dairy born calves available for beef production (AIM, 2017). With the introduction of the Dairy-Beef Index, it is anticipated that these will remain the beef breeds of choice for dairy producers due to their ease of calving and short gestation merits.

Johnstown Castle research

Research at Johnstown Castle examined various finishing strategies for early and late spring born Angus and Hereford dairy crossbred heifers and steers. Results showed that spring-born, early-maturing dairy crossbred heifers (February to April born) should be slaughtered before the second winter housing from 19 to 21 months of age. Research at Johnstown Castle also examined finishing heifers indoors during their second winter. While a greater carcass weight was achieved, winter finishing costs were inevitably incurred and some heifers were over fat at slaughter. An economical appraisal of that system highlighted that finishing heifers indoors was less profitable than finishing heifers at pasture despite greater carcass weights.

Early spring born early-maturing steers have the potential to be slaughtered at the end of the second grazing season. Previously, the blueprint for these steers involved a winter finishing period of 80 to 90 days. While both systems were profitable, finishing steers during the second winter was less profitable than pasture finishing. Alternative finishing strategies were also investigated for late-born steers. Animals were either finished indoors during the second winter or finished during their third season at pasture at 28 months of age. Steers that were finished indoors had a lighter carcass weight and that the system was less profitable than finishing animals during their third season at pasture.

The systems

The optimum production systems for early-maturing heifers and early and late born early-maturing steers are outlined below. Across all systems, calves are at pasture for the first grazing season. Target average daily gain during this period is 0.80 kg.

- **Early-maturing heifer production system:** After their first winter, heifers are turned out to pasture in early March and slaughtered off pasture at end of the second grazing season between September and November (19 to 21 months of age). Target carcass weight for this system is 235 to 250 kg. Carcass conformation for heifer production systems were predominately 'O=/' O+' with carcass fat classes of '3-/'.
- **February-born steer:** Steers are '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 0.80 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:** Steers are at pasture for the second grazing season, housed and offered good-quality grass silage supplemented with 5-6 kg of concentrates daily for 80 days pre-slaughter. Average daily gain during the finishing phase is 1kg. The target carcass weight is 300 kg with a conformation score of 'O+' and fat score '3='.
- **April-born steer:** Animals are at pasture for the second grazing season and are then housed and offered grass silage only on an *ad-libitum* basis, for the second winter. During this housing period ADG is typically 0.50 kg. Steers are then turned out to pasture in 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.



Production of spring-born Holstein/Friesian steers

Edward G. O'Riordan, Paul Cormican, Nicky Byrne and Donall Fahy

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

Summary

- Holstein/Friesian males are the most numerous animal type from the dairy herd.
- Steer production systems predominate.
- Carcass weight in excess of 315 kg at 24 months of age should be the target.
- Optimising performance at pasture is central to lowering production costs.
- Be realistic in your system output and cost assumptions.

Introduction

The national dairy herd mainly comprises Holstein/Friesian (Ho/Fr) cows, and Ho/Fr is the most commonly used sire on that herd. Of the 1.4 million calves born annually to the dairy herd, approximately 350,000 are Ho/Fr males, which are mainly spring born, and invariably find their way into the beef sector for rearing and finishing. Thus Ho/Fr males are the most numerous male breed emerging from the dairy herd. Rearing these calves as steers has predominated, where in excess of 75% are reared in this manner. Over the years a blueprint has been produced for the production of Ho/Fr beef at 24-months of age. This blueprint is being re-evaluated in the light of a trend towards the use of high EBI sires having shorter gestation length and easier calving characteristics, and the subsequent effect these may have on current production targets. This paper focuses on the production of steer beef at 24 months of age from Ho/Fr spring-born calves.

Blueprint for Holstein/Friesian steer production at 24 months of age

The blueprint target is to produce a Ho/Fr steer carcass with a weight in excess of 315 kg at 24 months of age. This production system typically resulted in carcasses where 80% graded 'O' and 20% graded 'P'. The system assumes a Feb/March born calf is available weighing approximately 45 kg at purchase. The calf is reared indoors for eight weeks, turned out to pasture in early May, rehoused in early-mid November, returned to pasture in spring as a yearling and finally rehoused in mid-October for finishing in March at 24 months old.

Concentrate inputs

Typical feed inputs are 25 kg calf milk replacer and around 80 kg of concentrates during the indoor calf rearing phase. On average, 1000 kg concentrates are fed over the animal's lifetime which, in addition to the calf indoor phase, is made up of 60 kg at pasture during their first year, 110 kg during their first winter and 750 kg during their final winter.

Grass and silage inputs

Grass inputs per animal are estimated to be 660 kg DM/head for the first grazing season and 1800 kg DM/head for the second grazing season. Grass silage inputs are estimated to be 500 kg DM/head during the first winter and 960 kg DM/head during the final winter. In

a 24-month Ho/Fr steer system the aim should be to harvest at least 55% of the farm for first cut silage and another 30-35% for the second harvest silage.

Live weight targets

In terms of live weight targets and daily gains, it is assumed the calf is following the typical rearing targets (see paper, 'Performance targets for the rearing period and first season at grass') where the weaned calf is turned out to pasture at 80 kg in early May. Concentrates are initially fed at pasture but withdrawn within 4 weeks. Concentrates may be introduced at pasture in the three week period before housing. Animal should have a live weight of 230 kg in early to mid-November, at housing. Yearling live weight at turn out to pasture should be 300 kg, and 490 kg by mid to late-October when housed for their final winter. A target live weight of 620 kg is the target at 24 months of age, thereby producing a carcass weight of at least 315 kg.

Depending on the farm carrying capacity or organic nitrogen targets (derogation or not) stocking rates up to 2.5 calf-to-beef units/ha can be carried (one calf plus one yearling to finish = 1LU). This level of performance requires management of the highest standards. Failing to achieve these output targets, while incurring all the input costs, will greatly erode profitability.

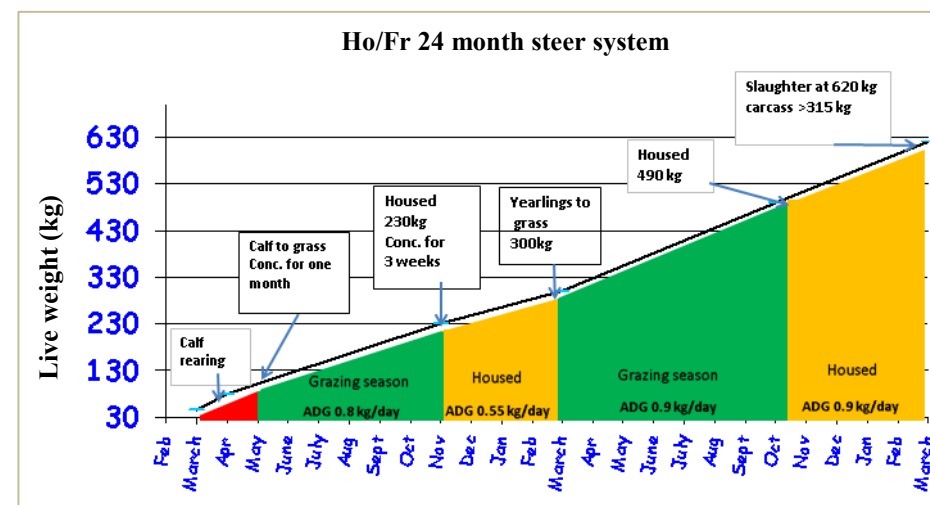


Figure 1. Live weight targets for Ho/Fr 24 month steer system.

Conclusions

The system demands attention to detail at all stages of production. Animal rearing and health standards, in addition to excellent grassland management, are essential. The production of high-quality (high DMD) grass silage is an important feature of the 24-month Ho/Fr steer beef system. Careful costings should be undertaken before embarking on this system of production.

Teagasc Green Acres Calf-to-Beef Programme Phase 2

David Argue¹, Sean Cummins², Alan Dillon³ and Pearse Kelly¹

¹Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

²Teagasc, Kildalton Agricultural College, Piltown, Co. Kilkenny

³Teagasc, Dromin Road, Nenagh, Co. Tipperary

Summary

- 14 farms have been selected for Phase 2 of the Teagasc Green Acres Calf-to-Beef Programme and two dedicated advisors and a programme manager have been appointed.
- The average net margin of the 14 farms in 2018 was minus €38/ha, ranging from minus €1,502 to €421/ha.

Introduction

Phase 2 of the Teagasc Green Acres Calf-to-Beef Programme was launched in April 2019. 14 demonstration farms have been selected across the country, each with an aim of achieving a net margin of €500/ha (excluding premia). Over the duration of the three year programme, David Argue and Sean Cummins, along with Alan Dillon, the Programme Manager, will work on an intensive basis with the demonstration farms to advise best practice on the rearing, growing and finishing of purchased dairy-bred calves through to beef. The knowledge gathered will be disseminated through AgriLand, media partner to the programme, Today's Farm and a series of national and regional events.

The Farm

14 farms have been selected for the second phase of the programme in various locations across Ireland, including: Wexford, Carlow, Kildare, Kilkenny, Waterford, Cork, Tipperary, Limerick, Galway, Mayo, Louth, Meath, Westmeath and Roscommon. The production systems in operation vary from calf to steer, calf to heifer and calf to bull beef, while land types range from heavy to very dry across the farms.



Financial and physical performance

Table 1 provides a snapshot of the physical and financial performance of the participating farms in 2018. The average farm size across the group is 53.6 ha – ranging from 10 ha to 94 ha. The stocking rate varies from 0.61 LU/ha up to 2.83 LU/ha, with the average sitting at 1.98 LU/ha. Across the 14 farms, the gross output (kg/ha) ranged from 531 kg/ha to 1,967 kg/ha, giving an average of 1,123 kg/ha in 2018.

Table 1. Physical and financial performance of the 14 Teagasc Green Acres farms in 2018.

	Average	Minimum	Maximum
Area (ha)	53.6	10	94
Stocking rate (LU/ha)	1.98	0.61	2.83
Gross output (kg/ha)	1,123	531	1,967
Gross output (€/ha)	1,821	975	3,682
Variable costs (€/ha)	1,275	517	2,299
Gross margin (€/ha)	600	412	1,641
Fixed costs (€/ha)	636	290	1,194
Net margin (€/ha)	-38	-1,502	421

The average gross output (€/ha) was €1,821/ha, with a range from €975/ha to €3,682/ha. The average variable costs across all farms was €1,275/ha; with the lowest variable costs at €517/ha while the largest variable costs were €2,299/ha. The gross margin varied from €412/ha to €1,641/ha, with the average being €600/ha. Fixed costs across the 14 farms were no higher than expected at an average of €636/ha. Fixed costs may increase on certain farms over the course of the programme especially if investments have to be made on buildings or grazing infrastructure. Finally, the net margin on the 14 farms ranged from minus €1,500/ha to €421/ha, with an average of minus €38/ha. These figures are excluding all farm premiums.

Conclusion

The starting point for farmers in Phase 2 of the Teagasc Green Acres Programme (net margin of -€38/ha) is similar to the level of efficiency witnessed at the commencement of Phase 1 (see paper, 'Lessons learned from phase 1 of the Green Acres Programme'). Over the course of the three year programme, procedures will be implemented in order to rise the net margins of these farms to an average of €500/ha (excluding premia). To achieve this target, a special focus will be placed on calf rearing, animal health, grassland management, soil fertility, financial management, and farm planning.

Acknowledgements

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Genetics

A Dairy-Beef Index (DBI) to rank beef bulls on profitability for use on dairy females

Nóirín McHugh¹, Siobhán Ring², Ross Evans², Andrew Cromie² and Donagh Berry³

¹Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

²Irish Cattle Breeding Federation, Highfield House, Bandon, Co. Cork

Summary

- The dairy-beef index (DBI) ranks beef bulls for use on dairy females based on their estimated genetic potential to produce high quality profitable cattle, with minimal impact on the dairy cow.
- Traits included in the index relate to calving performance, carcass traits, docility and polledness.
- Selecting beef bulls on the DBI versus the most-used beef bulls in dairy herds benefits both the dairy (€9.67) and finishing (€104.54) farmer.
- Research is on-going on the inclusion of additional traits such as calf health, meat quality and environmental traits.

Introduction

The expanding dairy herd, coupled with improving fertility, imply that a greater quantity of slaughtered animals in Ireland will originate from dairy herds; this demands a tool that ranks beef bulls based on suitability for use on dairy females. Such a ranking system should ideally rank bulls on estimated genetic potential for a high-value carcass produced in an efficient manner with minimal repercussions on the dairy cow in terms of milk, health and reproductive performance. Breeding indexes have been successfully used globally across many species, including in both dairy and beef cattle, to improve individual animal performance sustainably. With this in mind, the Dairy-Beef Index (DBI) was launched in January 2019 by the ICBF.

Construction of the Dairy-Beef index

For any trait to be considered for inclusion in a breeding index it must fulfil three prerequisites, namely:

1. It must be important (either economically, socially or environmentally),
2. It must exhibit inter-animal genetic variability,
3. It should be measureable (ideally early in life and at a low cost) or correlated with a trait that is measureable.

The DBI is made up of several component traits, each affecting the farm profit either through increasing revenue or reducing costs. The traits currently included in the DBI can be broadly classified into three trait groups:

Calving performance traits

In a recent ICBF survey, dairy farmers using beef bulls were less happy with their level of calving difficulty than dairy farmers not using beef bulls. Genetic differences among animals contribute up to one third of the variability in observed calving performance traits

and the impact of calving difficulty on subsequent performance in dairy cows is well established; therefore easy-calving bulls are desired. Short gestation length is a crucial component of ensuring the dairy cow calves early in the subsequent calving season to maximise profit; this is particularly important for a dairy-beef index where beef bulls tend, on average, to be used on later-calving dairy cows. In dairying, every one day delay in calving date costs, on average, €3.86 but of course the effect of delayed calving can persist for all remaining lactations. The opportunity cost of calf mortality is also obvious; over the last 10 years, the average value of a 14-day old spring-born calf from a Holstein-Friesian dam was €188.02, therefore calf mortality was included in the DBI.

Carcass and efficiency traits

Given the existence of genetic variability in carcass-related traits, genetic evaluations are currently undertaken for carcass weight, conformation and fat score, the latter two are characterised by the EUROP carcass classification system. Where applicable (i.e., breed specific) a carcass bonus trait was also included. The efficiency of an animal also has important financial ramifications at farm level; genetic evaluations already exist for feed intake in Irish beef bulls and have therefore been incorporated into the DBI.

Societal traits

The number of injuries and fatalities on Irish farms, largely attributable to livestock, demands action. Because docility is partly under genetic control, breeding programmes may offer a complementary solution to improving animal temperament. Polledness (i.e., no horns), which is important for animal and operator safety, is being ever-more scrutinised by consumers, particularly so when breeds, but also some animals within breeds, are naturally polled.

For the formation of the Dairy-beef index, each of the traits described above are weighted by their economic importance in terms of costs and prices experienced by dairy and beef farmers; the relative emphasis placed on the ten traits included the Dairy-beef index launched in January 2019 is summarised in Figure 1. Sixty-four percent of the emphasis is placed on the calving performance traits (i.e., calving difficulty, gestation length and calf mortality); these traits reflect the desirable attributes from the perspective of the dairy farmer. The remaining emphasis is on carcass merit (27%), feed intake (5%), docility (1%) and polledness (3%) which reflects animal characteristic sought after by the beef farmer and processors.

The DBI is expressed in euros (€), with each additional €1 expected to increase the profitability generated from the bull's progeny compared to progeny born to the average Holstein-Friesian bull. For example, a beef bull with a DBI of €100 is expected to produce progeny born to dairy cows that will generate, on average, €100 more profit compared to progeny sired by the average Holstein-Friesian bull. The active Dairy-beef index was launched in spring 2019 and only AI beef bulls with ≥30 progeny in dairy herds (i.e., born to dairy dams) were included in the list. In the future however, the DBI will be available for all beef bulls (both AI and stock bulls).

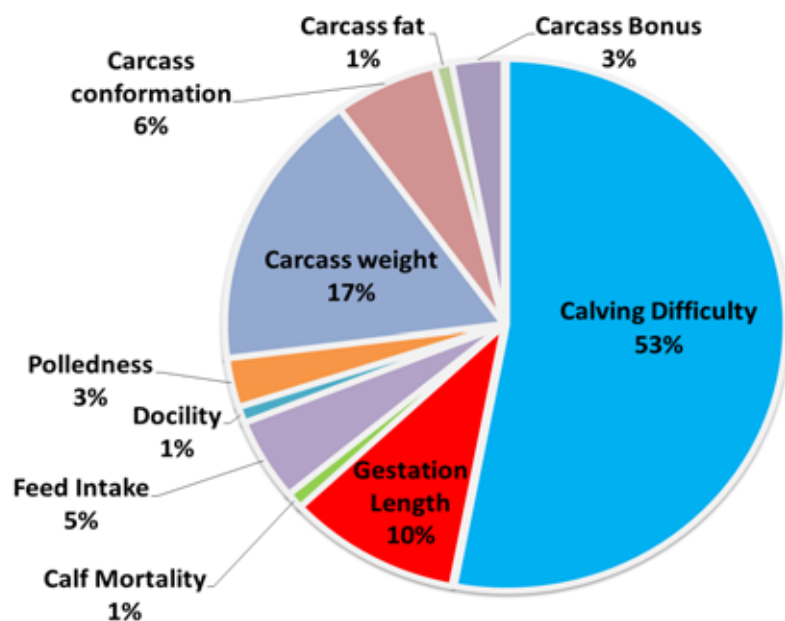


Figure 1. The relative emphasis of each trait included in the Dairy-beef index (DBI).

Benefits of the DBI

To illustrate the benefit of the Dairy-beef index to both dairy and beef farmers, the performance of progeny from the top five beef bulls ranked on the DBI active bull list was compared to the performance of progeny from the five most common beef bulls used in Irish dairy herds between the years 2015 and 2018 (Table 1). The results showed that the top five DBI beef bulls were easier calved on dairy cows (1 percentage unit easier) and generated a higher calf price (€18 more) compared to the five most used beef bulls on the dairy herd. The five most used beef bulls were, however, easier calved on dairy heifers (1 percentage unit easier) and had a slightly shorter gestation length (1 day). In economic terms, however, the additional benefits in calf price and easier calving in the top five DBI bulls would offset this and would result in the generation of a greater profit for the dairy farmer of €9.67 per calf produced. For the beef traits, the top five DBI beef bulls generated progeny that produced heavier carcasses (20 kg heavier) and had a superior conformation score (1 grade higher) which would result in the generation of an additional €104.54 to the finisher. The accumulation of benefits arising from using the top DBI bulls over the most used beef bulls was therefore €114.21.

Table 1. Mean performance of the progeny from the top five DBI bulls compared to the five most used beef bulls on the dairy herd on traits of interest to the dairy farmer and beef finisher.

Benefit	Trait	Top DBI Bulls	Most Used Beef Bulls	Difference
Dairy	DBI (€)	100	43	57
	Gestation length (days)	284	283	1
	Calving difficulty dairy heifers (%)	9	8	1
	Calving difficulty dairy cows (%)	3	4	-1
	Calf mortality (%)	2	2	0
Finisher	Calf price (€)	242	224	18
	Carcass weight (kg)	330	313	17
	Carcass conformation (grade)	R-	O+	1
	Carcass fat (class)	4-	4-	0

Future Research

Genetic indexes such as the DBI are constantly under review to ensure the index is always up-to-date and pertinent to future production environments. With this in mind, research is on-going on other traits that may be considered for inclusion in the DBI including, amongst others, calf vigour and health, life-time methane emissions, novel measures of meat quality and nutritive value, and saleable red meat yield. Scope also exists to use an adapted version of the DBI for trading animals, this version would focus solely on efficiency and carcass traits as the monetary costs of calving performance are of limited interest to the beef purchaser. DNA technology may be used to generate a more accurate selection tool as well as providing information on parentage verification and breed composition.

Conclusion

The DBI is a new selection tool available to dairy and beef farmers to promote high quality beef cattle bred from the dairy herd that are more saleable as calves and profitable at slaughter, yet have minimal consequences on the calving difficulty or gestation length of the dairy cow

Acknowledgements

Research underpinning the component traits and construction of the Dairy-beef index has been part-funded from the VistaMilk SFI Centre and GREENBREED.

The Gene Ireland Dairy-Beef Breeding Programme

Ciarán Costello

Irish Cattle Breeding Federation, Tully Test Centre, Co. Kildare

Summary

- The function of a breeding programme is to independently test the progeny of the bulls to allow for more accurate genetic/genomic evaluations.
- ICBF and Teagasc expects that beef AI usage in the dairy herd will grow significantly over the next number of years due to; an expanding dairy herd, demand for more beef from the dairy herd and the potential application of sexed semen technology.

Introduction

The objectives of the programme are to ensure more accurate genetic evaluations for beef traits related to the dairy herd, most notably calving difficulty, gestation length and calf quality and to help AI partners and pedigree breeders to identify new beef bloodlines that will be suitable for the dairy herd. AI companies provide the progeny test bulls for the programme and they are distributed to herds within the programme. This allows for greater efficiency through one national programme.

Short term benefits of the programme include a more accurate progeny test, while longer-term benefits include more accurate data for genomic predictions, index development and validation of indexes. The current focus for farmers using beef on dairy herd is ease of calving; however there is a strong negative association between calving traits and carcass conformation traits. This selection criteria will continue unless dairy farmers adopt an index-based approach when selecting beef bulls for their herd.

Progeny Testing

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

In order to improve the quality of dairy-origin beef calves, beef bulls must be tested on the dairy herd. To do this, dairy farmers interested in dairy-beef can acquire beef straws through the Dairy-Beef Gene Ireland Programme that have been selected by identified for progeny testing. Of the calves subsequently born, 600 are purchased by Teagasc/ABP at two to three weeks of age for the Teagasc/ABP Dairy-Beef Programme to be progeny tested; 250 calves are sent to Johnstown castle and 350 calves to the ABP Research Farm. The rest of the calves are reared commercially. The 600 purchased calves undergo subsequent growth, carcass and meat-eating quality analysis. Health and disease data is also collected on the purchased animals. A number of these heifers and steers are then performance tested in Tully Test Centre, Co. Kildare. Key measurements are recorded on

these animals in Tully such as feed intake, feed efficiency, average daily gain (ADG), methane production, carcass data and meat quality data.

Table 1. Data recorded on 2018 born calves.

	Number	%
Number of straws dispatched in 2017	6634	
Number of calves born in 2018	2017	30%
AI records	1636	81%
Number of sires recorded	2017	100%
Calving score recorded	1865	92%
Calf size recorded	447	22%
Calf vigor recorded	466	23%
Jersey x cows involved in programme	98	0.05%

Breeds that are available through the 2019 programme include: Aberdeen Angus, Aubrac, Belgian Blue, Blonde d'aquitaine, Charolais, Hereford, Limousin, Parthenaise, Piedmontese, Salers, Shorthorn and Simmental.

Table 2. Results to date from average calving difficulty and average carcass weight of bulls on the programme.

Year	Avg. CD %	Avg. Carc Wgt (kg)
2015	3%	7kg
2016	5%	11kg
2017	4%	9kg
2018	5%	20kg
2019	3%	21kg

Conclusion

There is a need for accurate data for all traits linked to profitable dairy-beef production, for example calving, gestation length, carcass weight, conformation, fat, feed intake, feed efficiency, health/disease, vigour and days to slaughter. The new Dairy-Beef Index has been developed with Teagasc for all cattle farmers and the industry. The Gene Ireland Dairy-Beef Breeding Programme has been and will continue to be key to providing the underlying data to support these developments.

The Gene Ireland Dairy-Beef breeding programme can play a significant role in genetic improvement into the future and will help improve on-farm profitability.

Acknowledgements

The author wishes to acknowledge the participation of all programme partners. These include AI companies, Breed societies, Teagasc, Bord Bia and ABP.

Genetics can increase the profitability of a dairy-beef system

Stephen M. Connolly^{1,3}, Andrew R. Cromie³, Ruth W. Fennell² and Padraig French¹

¹Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

²Teagasc, Animal & Grassland Research and Innovation Centre, Johnstown Castle, Co. Wexford

³Irish Cattle Breeding Federation, Bandon, Co. Cork

⁴ABP Food Group, ABP, Ardee, Co. Louth

Summary

- The use of beef genetics on the dairy herd is increasing each year.
- Dairy-beef carcass quality is decreasing on the quality pricing system (QPS) grid.
- Choosing beef calves sired by high genetic merit beef bulls could be worth as much as €17,800 in a 100 head dairy-beef production system.

Introduction

With the expansion of the dairy herd, dairy farmers are selecting beef sires for their herds solely on ease of calving and gestation length. Current research by ICBF and Teagasc has shown that, due to the selection of beef genetics for easy calving and short gestation, the quality of the beef cross animals coming from the dairy herd is declining for important economic traits, such as carcass weight and conformation.

The Teagasc/ABP dairy-beef programme

The ABP/Teagasc programme has three primary objectives:

1. To identify the most suitable beef bull genetics for crossing on dairy herds,
2. To genetically improve the main breeds supplying beef bulls to the dairy herd,
3. To understand the carbon efficiency savings due to sire.

Each year, 650 calves are purchased from farms at two to four weeks of age. These calves are reared under the ABP Blade Programme. At 15 weeks of age, 400 calves are moved to the ABP trial farm in Carlow until slaughter, while 250 calves are reared and finished at Teagasc, Johnstown Castle. Animal performance is measured throughout the production cycle and meat quality evaluations are made through collaboration with Meat Technology Ireland. To date, over 3250 calves have been purchased as part of the programme, with 1700 of these now slaughtered at ABP Cahir and Slaney Foods.

Results of the Teagasc/ABP dairy-beef programme

There were large variations in progeny performance between individual sires for key economic carcass traits, e.g. the Angus progeny from sire FPI had a 44kg heavier carcass than ZLT on average (Table 1). Similarly, progeny from the Hereford bull HE2147 had 38 kg heavier carcasses than CRP on average (Table 2).

How much is the right sire worth to a beef farmer's dairy-beef system?

Based on the results from Table 1, if a beef farmer purchases Angus calves from available AI bulls such as AA2309 rather than ZLT, there will be an increase in carcass weight of 38 kg per animal. The carcass conformation was better for ZLT progeny, and fat scores were similar for progeny from both sires. The progeny from AA2309 would leave an

increased carcass value of €112 per head, or €11,200 in a 100 head dairy-beef herd. Based on the ICBF Terminal Index, AA2309 is a 5-star bull for the carcass weight sub-index, whereas ZLT is only a 1-star bull. In addition, the progeny from AA2309 were slaughtered 22 days younger than ZLT progeny at a heavier carcass weight. Based on a cost of €3.00 per day, the progeny from AA2309 would have a reduction in on-farm costs of €66. Therefore, progeny from AA2309 could increase farm profit by €178 per animal or €17,800 in a 100 head dairy-beef herd. Progeny from AA2309 consumed 0.6 kg less feed per kilogram of live weight gain compared to ZLT progeny. Therefore, because the progeny from high genetic merit bulls are younger at slaughter, with heavier carcasses and with greater feed efficiency, considerable reductions in carbon emissions are possible for dairy-beef farms and the wider beef industry.

Table 1. The effects of Angus sire on carcass weight (Cwt), carcass conformation (Conf), carcass fat (Fat), kill-out % and carcass value.

Sire	Cwt (kg)	Conf (1-15)	Fat (1-15)	Value (€)*	Age (Days)
ZLT	279	7.18 (R-)	7.58 (3+)	1090	647
ZTP	281	5.74 (O+)	8.12 (4-)	1074	644
AA2025	283	5.99 (O+)	8.00 (4-)	1089	638
AA2203	311	5.87 (O+)	7.58 (3+)	1196	636
AA2309	317	6.37 (O+)	8.42 (4-)	1202	625
FPI	323	5.70 (O+)	7.33 (3+)	1247	651

*Carcass value is based on a €3.70/kg base price on the QPS grid, €0.12/kg quality assurance payment and €0.20/kg breed bonus payment.

Table 2. The effects of Hereford sire on carcass weight (Cwt), carcass conformation (Conf), carcass fat (Fat), kill-out % and carcass value.

Sire	Cwt (kg)	Conf (1-15)	Fat (1-15)	Value (€)*	Age (Days)
CRP	289	5.44 (O=)	8.29 (4-)	1100	640
YKM	292	5.66 (O+)	7.65 (3+)	1132	627
HE2463	294	5.02 (O=)	8.70 (4=)	1084	634
HWP	309	4.76 (O=)	7.77 (4-)	1155	633
GPZ	310	6.36 (O+)	7.75 (4-)	1210	638
HE2147	327	5.93 (O+)	7.78 (4-)	1267	638

*Carcass value is based on a €3.70/kg base price on the QPS grid, €0.12/kg quality assurance payment and €0.20/kg breed bonus payment.

Conclusion

The use of bulls with higher genetic merit for beef traits can have a major impact on a dairy-beef farmer's income. It is vital that beef farmers purchase calves based on their genetic merit alongside the calves' appearance and health status and, by doing this, calves of low genetic merit for beef will eventually be penalised in the market.

Genetic variability in beef merit of dairy cows

Alan Twomey
Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

Summary

- The national dairy breeding objective, the EBI, has resulted in a small, but constant, decline in the genetic beef merit of cattle from the dairy herd.
- Based on slaughter data nationally, the average difference in carcass value was only €53 for Angus progeny from Holstein X Jersey dams compared to Angus progeny from purebred Holstein-Friesian.
- Large variability exists in the genetic potential of beef progeny born to Holstein X Jersey dams, irrespective of sire.

Introduction

The increasing genetic gain in dairy herds for milk production and fertility, as well as breeding for smaller cows, has led to a decline in the beef merit of the Irish dairy herd. Additionally, there is a growing interest in crossbreeding among dairy farmers, with Teagasc, Moorepark showing that Holstein X Jersey cows are €162 more profitable compared to their parental breed average due to a combination of their superior milk production and fertility.

Trends in the beef merit of Holstein-Friesian cows

Since the year 1990, genetic merit for carcass weight in the Irish Holstein-Friesian population has gradually reduced (Figure 1). The annual decrease in genetic merit for carcass weight in Holstein-Friesian dams is 0.2 kg on average, which equates to a 4 kg reduction in carcass weight over 10 years for a 24 month steer at farm level. There was a genetic trend for poorer conformation and leaner carcasses from 1990 to 2000 in the Holstein-Friesian population, but has stabilised since 2000.

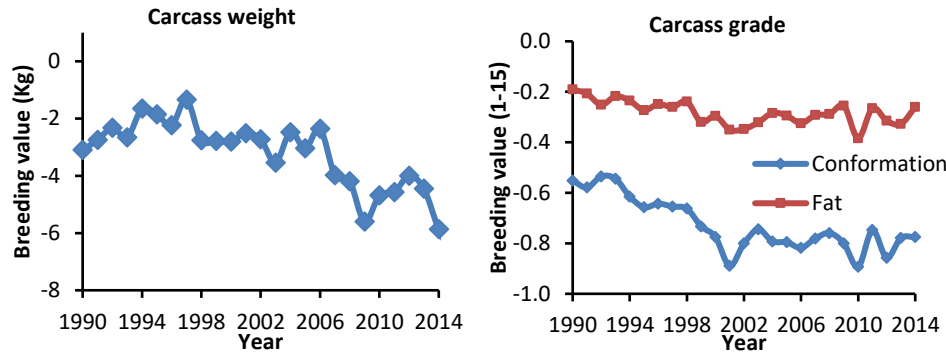


Figure 1. Genetic trend in beef merit by year of birth for Holstein-Friesian AI sires. Carcass conformation and fat are on a 15 point scale (i.e., 1= ‘P-’ and 15= ‘E+’ for conformation, 1= ‘1-’ and 15= ‘5+’ for fat).

Consequences of crossbreeding

Recent analysis at the Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, has shown that as the Jersey proportion of cows increase, the slaughter performance of their resulting beef progeny declines. Progeny born to Holstein-Friesian sires and Angus sires were evaluated across five different dam genotypes; 100% Holstein-Friesian, 33% Jersey (i.e., a two rotational way cross where the sire of the cow was a Holstein-Friesian), 50% Jersey (i.e., first cross between a Holstein-Friesian and a Jersey), 66% Jersey (a two rotational way cross where the sire of the cow was a Jersey) and 100% Jersey.

Table 1. Average slaughter performance nationally of progeny born to Holstein-Friesian and Angus sires from dams of varying Jersey proportion between the years 2008 and 2018¹

Breed	Jersey proportion of dam	Carcass weight (kg)	Carcass grade (1- 15)	Carcass Fat (1-15)	Value (€)	Age at slaughter (days)
Holstein-Friesian Sire	0%	323	3.76 (O-)	6.28 (2+)	1,101	834
	33%	314	3.95 (O-)	6.39 (2+)	1,072	836
	50%	310	3.81 (O-)	6.45 (2+)	1,052	838
	66%	305	3.82 (O-)	6.50 (2+)	1,036	840
	100%	296	3.86 (O-)	6.58 (3-)	1,003	843
Angus sire	0%	327	5.37 (O=)	7.00 (3-)	1,179	803
	33%	319	5.24 (O=)	7.11 (3-)	1,143	806
	50%	314	5.18 (O=)	7.16 (3-)	1,126	808
	66%	310	5.12 (O=)	7.22 (3-)	1,108	810
	100%	300	5.00 (O=)	7.32 (3-)	1,072	814

¹Referent animal is a steer slaughtered at 28 months, except for age at slaughter which is a steer slaughtered at 320 kg of carcass weight and a fat score of 7.

The main difference observed between progeny from dams differing in their Jersey proportion was carcass weight and age of slaughter; with conformation and fat score being relatively similar irrespective of the breed composition of the dam (Table 1). Nevertheless, the difference in carcass value was only €53 for Angus progeny from first cross dams (50% Jersey) compared to Angus progeny from purebred Holstein-Friesian. Additionally, progeny from first cross dams were five days older on average than progeny from purebred Holstein-Friesians at slaughter. Although, on average, progeny from Holstein X Jersey dams have a lower carcass weight than progeny from purebred Holstein-Friesians, there is large genetic variation for beef merit within dam breed.

Conclusion

Current dairy breeding strategies are causing a slow erosion of beef merit in dairy-beef progeny. Nevertheless, genetic potential still exists for high value dairy-beef progeny irrespective of dam breed.

Relationship between a sire's terminal index and the performance of beef progeny from the dairy herd during the finishing period

Stephen Conroy¹ and Thierry Pabiou²

¹ICBF, GENÉ IRELAND progeny test centre, Kildare town, Co. Kildare

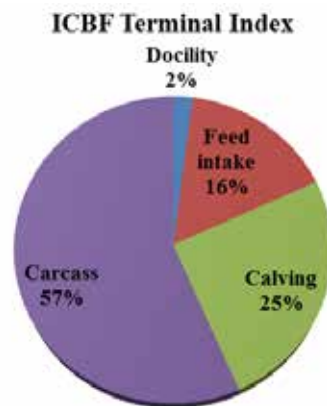
²ICBF, Highfield House, Shinagh, Bandon, Co. Cork

Summary

- This study looked at the relationship between a sire's terminal index and the finishing performance and carcass characteristics of 175 dairy beef progeny.
- Overall the progeny of 5-star terminal index beef bulls left €65 more profit than progeny from 1-star terminal index bulls.

Introduction

In Ireland farmers have achieved great success and increased farm profits by selecting animals through the Irish Cattle Breeding Federation (ICBF) Euro-Star or profit Indexes. These indexes allow farmers to select and breed the most profitable animals for terminal and replacement traits. The star rating system (1-5 stars) was incorporated into the Euro-Star Index to make it easier for farmers to interpret; 5 stars being good, 1 star being poor. Each of the important profit traits is given a weighting for the respective index and a monetary value is put on each trait. This is then calculated to give an overall figure that shows the potential financial impact of using a bull in your herd. If you take the Charolais bull Pirate (AI code: PTE) as an example; Pirate has a terminal index of €144 and is 5 stars within and across breed. This means that Pirate's progeny will leave €144 extra profit at slaughter over the average animal. It is important to remember that these are average figures, therefore, on farms where management and performance are very high, Pirate progeny may leave a lot more profit than the index suggests. By the same token, on farms where management and performance are poor, Pirate progeny may well leave a lot less profit than the average. Feed intake and conversion efficiency of animals is very important for a profitable beef production system. The terminal index has a weighting of 16% for feed intake and 56% for carcass traits.



Data collection at Tully progeny test centre, Kildare town

Data was collected on a total of 175 dairy-beef steers with an aim to look at the relationship of breeding more profitable dairy-beef animals based on their sire's terminal index. All steers in the study were from AI sired Angus, Hereford, Limousin and Shorthorn bulls. Animals spent a total of 120 days at the centre. During the first 30 days they were acclimatised to their diet and surroundings.

The following 90 days was their performance test period. Data collected included growth rate, feed intake, meat quality, ultrasound scans and carcass measurements. Animals were then slaughtered at an average age of 648 days. Animals were weighed once every three weeks from arrival to slaughter and feed intake was recorded daily through an insentec feeding system. Animals were weighed before slaughter in order to calculate their kill-out percentage. Following completion of the test, all animals were slaughtered in batches of between 40 and 50 cattle, all at the same abattoir.



Results from dairy-beef steers tested to date at Tully

The average daily gain was similar for each of the sire index groups in table 1. However, the dairy-beef steers from 5-star terminal index bulls consumed 1.5 kilo's less feed per day when compared to the 1-star sired dairy-beef steers. This equates to a difference in feed costs of €45 over a 100-day finishing period. Steers from 5-star terminal index sires produced 5 kilos more carcass despite being 6 kilos lighter at slaughter and had a higher kill-out of 1.2% when compared to steers from 1-star terminal index sires.

Table 1. Performance of dairy-beef steers based on their sire's terminal index.

Sire Index	No. of progeny	Final LW (kg)	ADG (kg)	DMI/Day (kg)	CW (kg)	KO %
5 Star (€106)	38	646	1.6	12.2	337	52.2
4 Star (€77)	32	656	1.7	13.1	338	51.6
3 Star (€65)	36	655	1.6	13.4	336	51.3
2 Star (€53)	35	660	1.6	13.5	338	51.2
1 Star (€31)	34	652	1.6	13.7	332	51

*ADG=average daily gain, CW= carcass weight, LW= live weight, KO= kill out.

Conclusion

Progeny from 5-star terminal index sires left €65 more profit than progeny from 1-star terminal index bulls, due to improved carcass weight and feed efficiency over the final 100 days of finishing.

Acknowledgements

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Genetics of carcass retail cut weights

Michelle Judge¹, Stephen Conroy², Thierry Pabiau², Andrew Cromie², P.J. Hegarty², Jessica Murphy⁴ and Donagh Berry¹

¹Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

²Irish Cattle Breeding Federation, Highfield House, Bandon, Co. Cork

³Slaney Foods International, Bunclody, Co. Wexford, Ireland

Summary

- Altering the morphology of cattle towards greater yields of higher value cuts could increase the value of animals at slaughter.
- The weight of striploins from animals ranked in the top 25% genetically were 12 to 24% heavier than striploins from animals predicted to be in the worst 25% genetically for that cut.

Introduction

Beef breeding programmes aim to improve the morphology of animals towards greater saleable meat yield. Traditionally this was achieved by increasing overall carcass weight; the consequence of this on production efficiency has led to the investigation of alternative ways to increase saleable meat yield without impacting carcass weight.

The potential of breeding to increase the weight of primal cuts

Differences in the performance of animals are due to both management (e.g. nutrition) and genetic effects. Genetic improvement is both cumulative and permanent implying that the performance of the animal for a particular trait is a function of the past decades of breeding, and improvements made in one generation can be further added to by successive generations. The *heritability* of a trait is the amount of variation between animals for the specific traits that is due to genetics. Accurate estimates of performance are a function of (among others) the quality of the information included into the genetic evaluations; with the use of detailed retail cut yields, scope for improvement in the precision of genetic evaluations possibly exists. Carcass information, as well as the weight of individual primal cuts, was available on 127,635 steers and 64,606 heifers. This data was used to estimate the genetic parameters of carcass retail cuts and to quantify the gains that can be achieved by increasing the weight of these cuts without increasing overall carcass weight.

Genetic variability exists in the weight of primal cuts

The rump cut has a heritability of 0.26, which means that 26% of the variability between animals in the weight of the rump cut is due to genetics. For beef production to be efficient, breeding for heavier retail cuts needs to be achieved without a simultaneous increase in carcass weight. On average 31 to 47% of the variability in the weight of the high value rump, striploin and fillet cuts is independent of carcass weight. This implies that there is a lot of variation between animals in the weight of retail cuts, even when animals are the same carcass weight.

Validation of results

The genetic merit for the weight of the rump, striploin and fillet of 3,745, 4,237 and 3,804 animals, respectively, was predicted just from their ancestral information prior to the animals being slaughtered. Animals were subsequently divided into four genetic merit groups based on predicted retail cut weight; the weight of cuts from animals in the very low genetic merit group was expected to be the lightest and the weight of cuts from the highest genetic merit group were expected to be the heaviest. After slaughter, the weight of the individual retail cuts of each animal was measured. The predicted results from genetic analysis and the actual weight of each of the cuts were then compared (Table 1). The weights have been adjusted to account for environmental impacts that could influence the results, such as slaughter date and gender of the animal.

Table 1. Average weight for the rump and striploin by stratum of parental average genetic merit for each cut weight, with and without adjustment to a common carcass weight.

	Genetic Merit	Average weight (kg)	
		Unadjusted (SE)	Adjusted (SE)
Rump	Very light	11.23 (0.16)	12.79 (0.10)
	Light	12.46 (0.15)	13.36 (0.10)
	Medium	13.61 (0.15)	13.79 (0.10)
	Heavy	13.92 (0.15)	14.07 (0.10)
Striploin	Very light	11.91 (0.16)	13.28 (0.12)
	Light	12.82 (0.16)	13.89 (0.12)
	Medium	14.42 (0.16)	14.51 (0.12)
	Heavy	14.71 (0.16)	14.87 (0.12)

The weights have also been adjusted to a common carcass weight, to remove the effect of heavier animals having heavier cuts of meat. The weight of the rump cut from animals in the heavy genetic merit stratum was 24% heavier than animals in the very light genetic merit stratum when there was no adjustment for carcass weight. After adjusting for carcass weight, the weight of the rump cut between the diverse genetic merit strata reduced (as expected) to 10%.

Conclusion

Considerable genetic variation exists in the weight of primal cuts among animals. With more data, it will be possible to investigate the usefulness of including the weight of individual retail cuts into the genetic indexes to produce more saleable yield from more profitable animals, without increasing overall carcass weight.

Grange dairy calf-to-beef system evaluation

Nicky Byrne, Edward O'Riordan and Donall Fahy

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

Summary

- The aim is to provide improved direction for calf-to-beef production systems.
- The system evaluation will assess the contribution of genetics to physical and financial performance of calf-to-beef systems.

Introduction

The objective of the study is to compare the physical and financial performance of progeny from both Holstein Friesian and Angus sires used in the dairy herd that are divergent in breeding value for carcass weight and conformation, managed within an efficient grass-based production system. The new Grange calf-to-beef herd is of fundamental importance to the industry and will provide direction and confidence to beef producers. Holstein Friesian (HF) and Angus (AA) sires were selected as they represent the main calf breeds coming from the dairy herd, respectively. Each year, 120 calves are purchased following strict selection criteria;

- Born to Holstein Friesian dams,
- Born from dams inseminated between 27 March and 25 June,
- Maximum sire calving difficulty PTA of 3.5%,
- Bred to AI AA sires;
 - Minimum Terminal Reliability of 60%
 - Maximize divergence for carcass weight & conformation PTAs
- Bred to top four EBI (HF) sires on the active bull list at time of insemination.

Management

Three animal genotype groups were formed, with each having their own individual farmlet, implementing an intensive grass-based, under 24 month steer production system; 40 HIGH (sired by six high carcass weigh & conformation AA bulls), 40 LOW (sired by six high carcass weight and conformation AA bulls) and 40 HF (sired by top four EBI HF bulls). Each farmlet is stocked at 2.7 LU/ha, consisting of 40 calves (0 to 12 months) and 40 yearlings (12 to 24 months). The live weight, grazing efficiency, winter feed intake, linear measurements and slaughter performance of each genotype group are measured. All inputs into each system are fully costed and measured to determine the contribution of each genotype to farm profit.



Calves arrive on farm at approximately 21 days of age. Calves are assigned to two different milk feeding levels; 4 L or 8 L of milk replacer per calf per day. Milk feeding

treatments are balanced by sire, arrival weight and age. All calves have *ad lib* access to concentrate over the rearing period, with individual milk and concentrate intakes recorded. Weaning of calves begins once they hit a target weight of 85 kg. Calves are then turned out to pasture for the first grazing season and strategically supplemented with concentrates (1.5 kg reducing to 1 kg) for the first month at pasture. Thereafter, they are offered only pasture until mid-September when 1 kg of concentrates is offered until housing in November. All calves are castrated at 5 months of age.

Table 1. Breeding value per genotype (HF) and sire.

Genotype (AI code)	EBI (€)	Calving traits			Carcass Performance		
		Calving difficulty (%)	Gestation length (days)	Beef sub index (€)	kg	Con	Fat
HF	302	2.5	-3.8	-11	-5	-1	0
FR2239	314	2.4	-5.29	-2	0	-0.53	-0.39
FR2460	312	2.8	-2.38	-17	-9	-0.39	-0.13
FR2385	291	2.3	-4.48	-6	-2	-0.46	-0.3
FR4021	291	2.6	-3.07	-18	-9	-0.65	-0.2

Table 2. Breeding value per genotype and sire for High and Low animal groups.

Genotype (AI code)	Terminal Index	Calving traits		Carcass Performance		
		Calving difficulty (%)	Gestation length (days)	kg	Con	Fat
High	€86	2.5	-1.8	11	0.87	0.47
AA2037	€76	3.8	-2.9	10	0.55	0.48
AA4195	€78	1.8	-2.9	10	0.48	0.40
AA4375	€119	2.8	-1.5	21	1.19	0.39
RGZ	€66	2.5	-0.8	9	0.79	0.65
WZG	€90	2.8	-1.8	8	1.27	0.32
ZEP	€85	1.5	-1.1	8	0.95	0.57
Low	€51	1.4	-2.4	-3.2	0.57	0.60
AA2123	€61	2.4	-3.9	6	0.33	0.39
AA2259	€58	1.7	0.0	-2	0.76	0.77
JZJ	€61	0.8	-3.2	-1	0.68	0.68
KYA	€66	0.8	-4.8	-2	0.45	0.19
SYT	41	1.8	-1.5	-4	0.56	0.78
ZTP	19	0.7	-1.3	-16	0.61	0.81

Conclusion

This trial has the ability to determine the merit of using elite beef genetics on the dairy herd, whilst analysing overall system functionality. The data captured from this trial will provide an improved blueprint for dairy calf-to-beef production systems.



Calf Rearing and Health

Tackling the issue of Antimicrobial Resistance

Caroline Garvan and Julie Bolton

Antimicrobial Resistance Section, Department of Agriculture, Food and the Marine, Backweston Campus, Celbridge, Co Kildare, Ireland.

Summary

- Reducing the quantity of antibiotics being used in the both the human and animal health sector is paramount to addressing the challenge of AMR.
- Better animal health through improved animal husbandry will reduce the need for antibiotics.
- The Six Rights ('6 R's') must be followed when using antibiotics.

Introduction

The discovery of antibiotics in the past 100 years has revolutionised modern medicine and prolonged life expectancy across the globe. In animal health, antibiotics are vital tools to protect health and welfare, productivity, and facilitate the production of safe, nutritious food. The emergence and spread of antimicrobial resistance (AMR) is one of the greatest threats to modern health care. Without effective antibiotics, infections that were once deemed relatively minor have the potential to kill. Scientists estimate that if AMR continues to spread at current levels, by 2050, 10 million people may die from AMR related infections, more than the death toll due to cancer. While it is scientifically proven that the problem of AMR in humans is largely caused by the overuse of antibiotics in humans, the use of antibiotics in animal health has the potential to contribute to the AMR issue.

What is AMR?

Antimicrobial resistance (AMR) is the ability of a microorganism (like bacteria, viruses, and some parasites) to survive treatment with an antimicrobial medicine, (such as antibiotics) that should be capable of killing it when given at the correct dose. In other words, the antibiotic is no longer effective to treat the infection. In general when we talk about AMR we are referring to bacterial resistance to antibiotics. The term antibiotic residue should not be confused with AMR. If there is an antibiotic residue in the food, this means that there are traces of antibiotics and associated metabolites remaining in meat and milk from animals that have been treated with antibiotics. If a farmer adheres to the required withdrawal period for an antibiotic, then there is no risk of an antibiotic residue occurring in the meat or milk from the treated animal. However adhering to the withdrawal period to prevent an antibiotic residue does not prevent the development of bacterial resistance over time. Any use of antibiotics will, over time, lead to bacteria becoming resistant to these veterinary medicines, and the antibiotics will become less effective at treating disease.

How resistance develops

The development of AMR is a natural phenomenon; bacteria have been around for millions of years and have developed various survival mechanisms, including resistance

genes. Every time we use antibiotics some of the stronger bacteria develop resistance genes which allow them to survive treatment with an antibiotic. The misuse and overuse of antibiotics accelerates the rate at which resistance develops.

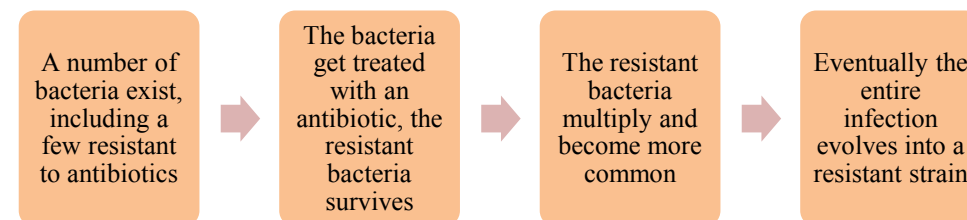


Figure 1. How antimicrobial resistance develops.

What are HP-CIAs?

HP-CIAs stand for Highest Priority Critically Important Antimicrobials. These are the drugs used as a last resort for treating many bacterial infections in humans. Given the importance of HP-CIAs in human health, strict controls should be applied to their use in veterinary medicine.

In order to protect the efficacy of these drugs in humans, it is crucial that these antibiotics are never used prophylactically i.e. to prevent disease, or as a first line of treatment in animals. Veterinary practitioners should only prescribe these antibiotics (Table 1) when there are no effective alternative antibiotics available for the treatment of the bacterial disease, as proven by the results of culture and sensitivity testing of samples taken from clinically affected animals. In Ireland, the DAFM has published a policy document which outlines the conditions under which these last resort antibiotics should be used in veterinary medicine.

Table 1. Antibiotics licenced for sale in Ireland containing HP-CIAs. (Source HPR website accessed Feb 2019)

Antimicrobial family	Active ingredient	Examples of product trade names
Fluoroquinolones	Enrofloxacin	Baytril, Enrocare, Enrotril, Colmyl, Doraflox, Enrodexil, Enrotron, Enrox, Enroxil, Fenoflox, Floxibac, Kariflox, Quinoflox, Roxacin.
	Marbofloxacin	Marbocyl, Marbocare, Marbonor, Boflox, Forcyl, Kelacyl, Marbim, Marbosyva, Marfloxin, Marbox, Masterflox

3 rd and 4 th Generation Cephalosporins	Cefquinome	Cobactan, Ceffect, Cefimam, Cephaguard, Qivitan.
	Ceftiofur	Excenel, Naxcel, Alfacef, Cefavex, Cefenil, Cefokel, Ceftiocyl, Cevaxel, Cemay, Curacef, Eficur
Polymixins	Colistin	Coliscour, Colfive, Hydrocol, Sogecoli,
Macrolides	Tylosin	Bilosin, Bilovet, Pharmasin, Tylan, Tylo, Tylosin, Tylovet, Tylucyl
	Erythromycin	Erythrocin
	Gamithromycin	Zactran
	Tildipirosin	Zuprevo
	Tulathromycin	Draxxin
	Tilmicosin	Hymatil, Micotil, Milbotyl, Pulmotil, Pulmovet, Tilmodyl, Tilmovet

Reducing the dependence on antimicrobials

On Irish dairy and beef farms some of the more common conditions in calves necessitating treatment with antibiotics are scour, pneumonia, navel ill, joint ill and septicæmia. In Ireland, scour is the most common cause of death in neonatal calves less than one month of age, while pneumonia is the most frequent killer of calves aged between one and five months. In order to address the rising problem of AMR, reducing the dependence on antibiotics and the amount being used on farms is fundamental. To do this, farmers must focus their efforts on improving animal health and disease prevention through better farm management practices and good animal husbandry; as is always the case, prevention is better than the cure.

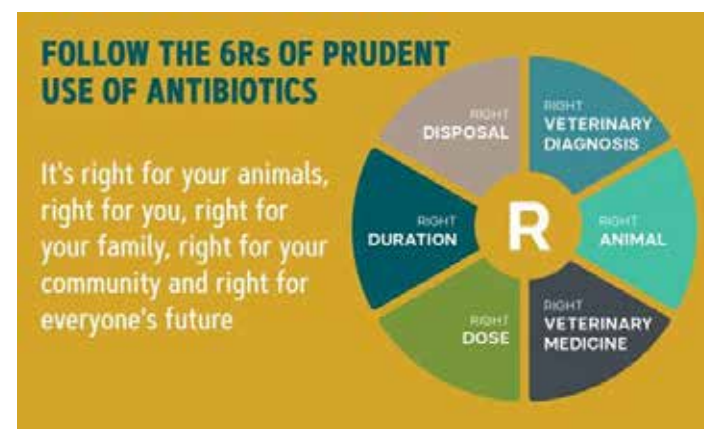
To begin with, it is essential that calves receive an adequate volume of good quality colostrum in the first two hours after birth. Colostrum derived passive immunity is vital to the health, performance and welfare of new-born calves and greatly reduces the need for antibiotic treatments, both in the first few weeks of life and throughout the animal's lifetime. In all age groups, good biosecurity, thorough vaccination policies, adequate housing, nutrition, optimal stocking densities and parasite control are the corner-stones of disease prevention. Antibiotics must not be used to compensate for poor farm management practices. Increased use of vaccines will reduce disease levels and the need to use antibiotics.

The Six 'R's'

The 'Six Rights' should be applied when using antibiotics:

1. **Right veterinary diagnosis;** accurate diagnosis is essential to identify if an animal is suffering from a bacterial infection that will benefit from treatment with an antibiotic. Veterinary practitioners are best placed to make this decision.
2. **Right animal;** only an animal that has a bacterial disease should be treated with an antibiotic.
3. **Right veterinary medicine;** antibiotics should only be used when absolutely necessary, and when the vet has diagnosed that there is a bacterial disease present. The antibiotic chosen for treatment should be effective to treat against the particular bacteria causing the disease. Bacterial isolates should ideally be tested for antibiotic sensitivity to ensure that there are no problems with resistance.
4. **Right dose;** antibiotics should be administered as per the instructions on the prescription. Animal weights should be estimated as accurately as possible. Under dosing animals accelerates the rate of resistance development.
5. **Right duration;** antibiotics should be given as directed by the vet. Do not stop the course prematurely as this will not fully treat the disease and may result in resistance to this antibiotic in the future.
6. **Right storage and disposal;** all medicines should be stored according to the manufacturer's instructions in order to maintain their efficacy. All out-of-date medicines, containers and application equipment (including needles to a sharps container) should be placed in appropriate clinical waste containers. Antibiotics should never be disposed of with domestic rubbish or poured down the drain or toilet as this leads to development of resistant bacteria in the environment.

A "Code of Good Practice Regarding the Responsible Prescribing and Use of Antibiotics in Farm Animals" was launched in November 2018 and is available for download at www.agriculture.gov.ie/amr. The development of and spread of AMR is a challenge for public and animal health into the future, we all have a role to play in keeping antibiotics effective for future generations.



Getting the calf off to the best start

Sean Cummins¹, David Argue², Alan Dillon³ and Pearse Kelly²

¹Teagasc, Kildalton Agricultural College, Piltown, Co. Kilkenny

²Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

³Teagasc, Dromin Road, Nenagh, Co. Tipperary

Summary

- The calf rearing phase is critical for performance and profitability.
- Buy a calf that suits your system from a known source.
- Be prepared – labour input and costs increase where facilities are not suitable to calf rearing.

Introduction

Under the correct management, calf to beef systems can be profitable and the aim of the Teagasc Green Acres Calf to Beef Programme is to demonstrate best practice in this regard. Central to achieving profitability are the quality of the calf purchased and the success of the calf rearing stage. To maximise profits under such systems, careful consideration needs to be given to the sourcing, purchasing and rearing of calves.

The right start

The first three months of a calf to beef system are critical to the overall level of performance and profitability that is likely to be achieved. Growth rates realised during this period can impact on the lifetime performance of the animal. Failing to protect performance during this phase can have negative impacts on the enterprise's bottom line. Buying the right calf, optimising the calf's nutrition and health, along with limiting disease pressure, are absolutely critical during this period.

Purchasing the calf

The quality of the calf purchased has a major impact on the profitability of dairy-beef enterprises. Purchasing poor-quality calves leads to lessor feed efficiencies, weight gains and thrive and potentially higher morbidity and mortality rates. Careful consideration should also be given to calf weight; low-weight calves are associated with high mortality rates within the first four weeks of arrival on farm.

Key factors to consider:

- ✓ Source only healthy calves from reliable suppliers.
- ✓ Calves should ideally be sourced from dairy farms that feed calves adequate levels of colostrum and have a high herd health status.
- ✓ Seek information on the herd's health and feeding protocol, vaccination programme and any current or previous disease issues.
- ✓ Examine the calf thoroughly prior to purchase.
- ✓ Ask for the sire details; target calves sired by bulls with positive carcass weight and conformation characteristics.
- ✓ Don't purchase young calves.

The calf's traits

- Target calves that will suit your system; remember demand relating to the breed-specific bonuses is strongest for carcasses with a conformation of O= or better.
- Select calves with no visible signs of disease, diarrhoea, discharge (mouth/eyes/nose), deformity, disability, injury or blindness.
- Calves should be alert with a clean, damp nose and bright eyes.
- Hooves should be firm and worn flat, not bulbous or round with soft, unworn tissue. Calves must not be lame and must be able to bear weight on all limbs.
- Navel cord should be dry, withered and shrivelled, not pink/red, raw or fleshy.

Be prepared

Calf rearing is one of the most critical times for dairy calf to beef systems and it's also the most labour intensive task for producers. Remember, labour input and costs increase where facilities are not conducive to calf rearing.

Steps to prepare for calf rearing:

- Identify the strengths and weaknesses of the housing on your farm. Are your sheds well ventilated and draught free?
- Have all the necessary feeding equipment to hand before the arrival of calves – water heaters, carts to transport the milk replacer, milk feeders and concentrate feeders.
- Clean and disinfect this equipment between batches of calves.
- Prepare pens before the arrival of calves to your farm.
- Quarantine new arrivals and don't let them join other calves until you are sure they are healthy, adapted to your system and are free from disease. A minimum quarantine period of seven days is a must.

Feeding the calf upon arrival

It is common for calves to lose weight due to a lack of food and water during transportation. If not addressed, this can lead to dehydration, loss of electrolytes and low blood sugar. To help counteract this, two litres of electrolytes should be given after resting for two to three hours (Table 1). This will help reduce dehydration and increase appetite.

Table 1. Feeding schedule for the first four days.

Day	Time	Feeding Schedule	Concentrates
1	PM	Provide <i>ad-lib</i> access to warm electrolyte solution and allow the calf to rest overnight	----
2	AM	Two litres of milk replacer (38° C)	----
	PM	Two litres of electrolyte solution (38° C)	----
3	AM	Two litres of milk replacer (38° C)	Handful
	PM	Two litres of electrolyte solution (38° C)	Handful
4		Normal feeding schedule	<i>Ad-lib</i>

Optimising immunity in dairy-beef calves

Ruth W. Fennell¹, John Barry² and Bernadette Earley³

¹Teagasc, Animal & Grassland Research and Innovation Programme, Johnstown Castle, Wexford

²Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

³Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary

- Early intake of good quality colostrum is a key pillar to a healthy immune system.
- Farmers must minimise stress, especially during the 'high-risk' period.
- Good vaccination programme, farm hygiene and nutrition are important factors.

Introduction

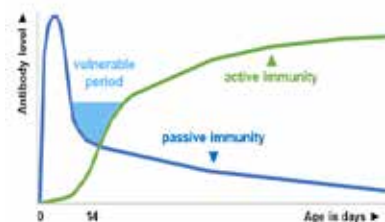
Despite advances in calf rearing, over 50% of calf mortality within the first year occurs during first six weeks of life. Two crucial targets for dairy-beef farmers is a low morbidity rate (less than 10%) and to keep mortality below 5%. Disease resistance is a balance between the microorganisms the calf is exposed to and how well the calf's immune system is functioning. To improve disease resistance, farmers must aim to reduce exposure to infectious agents in the environment, maintain optimal calf husbandry management, while also ensuring the calf is not immune-compromised.

Colostrum is Crucial

A calf is born without protective immunoglobulins (Ig) to fight against disease. Maternal colostrum is a rich source of Ig and the calf depends on the passive transfer of these Igs to defend itself against infection until its own active immunity becomes functional. The calf should receive 8.5% of its birth bodyweight in good quality colostrum within two hours of birth. Calves that do not receive colostrum are at an increased risk of developing scours and 74 times more likely to die in the first three weeks of life. While those who purchase calves at two to three weeks of age have little control over colostrum feeding and early nutrition they receive, farmers can test for Failure of Passive Transfer (FPT) using the Zinc Sulphate Turbidity (ZST) test in calves that are under seven days of age. This can be done by measuring Ig levels in calf serum. Adequate colostral immunity is defined as a ZST result of 20 units or greater.

Keep stress to a minimum

The 'immunity gap' is a vulnerable period between four and 14 days of age when colostral immunity diminishes and the calf's own immunity is still developing. During this high-risk period, farmers should avoid conducting tasks which may cause stress, such as disbudding, castration and transportation. Stress increases serum cortisol levels (stress hormone), and prolonged increases in stress hormones and other oxidative stress biomarkers can lead to Bovine Respiratory Disease (BRD) and mortality in calves. When possible, farmers should avoid transporting calves until they are three weeks of age. Environmental stress should also be minimised, for example a calf greater than three



weeks of age should be kept in a thermo-neutral zone between 5.5°C and 27.8°C.

Know the herd of origin

Dairy-beef farmers should, where possible, aim to purchase calves from dairy herds where the health status and vaccination protocols in place are known. Ideally, farmers should try to purchase calves from herds vaccinated for pneumonia (e.g. PI3, IBR) and scour (rotavirus, coronavirus, *E. coli*).

Implement a vaccination protocol

Two of the most common health issues of dairy-beef calves are pneumonia and scour. Farmers should implement a sound preventative policy whereby calves are vaccinated within the first few weeks of life against the common viral causes of calf pneumonia (BoHV1, BRSV and PI-3 viruses). Calves should be closely monitored for signs of coccidiosis from three weeks of age, and where coccidiosis issues were previously experienced, prophylactic coccidiostats should be used.

Nutrition

Maintenance level of intake is the amount of energy and/or protein required by the animal to maintain its current bodyweight. Calf diets are formulated to contain enough energy/protein for both maintenance and growth. When calves are fed limited amounts of calf milk replacer, particularly in cold weather, they may not receive the necessary calories to meet their maintenance requirements. In these situations, calves will lose bodyweight and their immune systems will be compromised.

Gastro-intestinal (GI) health

By encouraging the growth of the calves' gut microflora, farmers can prevent invasion by infectious pathogens and minimise GI health issues. Probiotics are live bacteria that are fed to, and benefit, the animal through improvements in their gut microflora. Prebiotics are carbohydrates which are not broken down in the small intestine, but are fermented in the large intestine, acting as a feedstuff for the growth of beneficial bacteria.

Farm hygiene

Good hygiene is important in a calf rearing system to minimise exposure to infectious agents. Calves should be kept in a clean, well bedded and well ventilated house. Build-up of faecal contamination around feed and water troughs must be avoided. For farms purchasing calves over an extended time period, new arrivals should be quarantined for at least one week. Farmers should avoid mixing groups of calves, and calves of different ages, as they will have different immunity levels.

Conclusion

Dairy-beef farmer have limited control over the management of the calf in its early life, however, many opportunities are available for them to improve the immune-competence of the calves they purchase. Farmers that buy calves directly from dairy farms must aim to establish the health status of the animals and the herd of origin. From then, farmers must aim to reduce stress, improve immunity through vaccination and nutrition, while keeping exposure of infectious pathogens to a minimum.

Nutritional management of dairy-bred beef calves

David Kenny¹ and Alan Kelly²

¹Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

²School of Agriculture and Food Science University College Dublin

Summary

- Meeting the calves nutritional needs in early life will have lasting effects on its subsequent productive potential.
- Feed conversion efficiency is highest during early calf-hood and reduces substantially as the animal matures.
- A key aim of any artificial calf rearing program is achieving a smooth transition from a liquid based diet pre-weaning to adequate consumption of solid feed.

Introduction

There is now significant evidence to suggest that the nutritional management of the artificially reared calf has a lasting impact on the animals' productive potential. Given the relatively high cost of the pre-weaning period, achieving acceptable calf performance coupled with a smooth transition from a liquid to a solid feed based diet are key objectives. In general, the ability of young calves (i.e. less than six months of age) to 'compensate' or 'catch up' following a period of under-nutrition is limited and therefore moderate to high growth performance must be achieved in order to consistently meet acceptable lifetime performance targets

Milk replacer: composition and feeding

The amount of milk replacer (MR) offered will depend on its nutritional composition and the body weight and desired growth rate of the calf. For successful calf rearing, the target is to achieve a pre-weaning growth rate of 700g per day, resulting in the calf reaching a body weight of 100 kg at 12 weeks. Feeding rates typically range between 100 to 125g/litre. To meet the calf growth targets a standard MR at a feeding rate of six litres (125g/l; split between two feeds), equating to 750g of powder per day has been traditionally recommended. Research from Grange shows no advantage in raising the protein content of MR from 23% to 28%. For this reason, the requirement for protein in dairy-beef is lower and MR should contain a minimum of 22 to 23% protein and 15 to 20% fat. The target MR ash content is 6.5 to 7%. Higher ash levels are associated with higher incidence of digestive disorders and scour. In general, MR containing milk products (skim and whey based) are digested better than those containing vegetable proteins and are particularly beneficial for younger calves that may be more susceptible to stress. Additionally, most MR can also be fed as a once-a-day product with no difference in calf performance, if feeding guidelines are followed correctly.

Conventional versus Intensified Feeding Systems

Intensified feeding of calves for accelerated growth is a hot topic in calf management. Such rearing systems allow calves much greater intakes of MR in early life, with feeding rates approximately twice those offered under conventional systems. Feeding a MR

containing a higher crude protein content (25 to 28%) to support the potential for rapid lean growth is typically advocated under such systems. Target live weight at three months is 115 to 120 kg following a MR input of more than 50kg. Research shows that calf growth rate responds to increasing MR allowance up to 1200g/day pre weaning. However, from a dairy-beef perspective the economic payback for this additional investment is highly dependent on the prevailing value of beef and the relative importance of meeting carcass specifications in a timely fashion (i.e. young bull beef systems).

Rumen development

An orchestrated and timely transition from the pre-ruminant to the ruminant state is a key objective of any calf rearing system. The consumption of starch-based concentrates stimulates rumen development through microbial fermentation in the rumen. The volatile fatty acids (VFA) produced, particularly butyrate, stimulates the growth and development of rumen papillae. These 'finger like' projections of the rumen lining greatly increase the surface area of the rumen for increased nutrient absorption. It takes about three to four weeks to develop the rumen papillae from the initial time that concentrate is offered. Optimal nutritional management plays a crucial role in determining rumen development and ultimately will determine weaning age.

- I. **Concentrates are the key to success:** High quality calf starter should be offered to calves within by four days of age with daily consumption approximately 300g at two weeks of age. Calf starter should be high-quality, offered fresh on a daily basis and clean water should be freely available. Finely ground, dusty feeds should be avoided. Calf concentrate should contain 17 to 18% crude protein and have an energy value of at least 12 MJ/kg (greater than 0.95 UFV/kg).
- II. **Feeding roughage:** Roughage, such as hay or chopped straw, is not necessarily required until calves are consuming at least 1.5kg of concentrate, which typically doesn't occur until after weaning. Long forage is beneficial to promote the growth of the rumen muscular layer and maintain the health of rumen epithelium. A general recommendation would be to offer roughage starting at week eight and monitor meal intake to avoid excessive consumption of forage which dilutes overall dietary energy content and can lead to 'pot belly' condition. In order to limit this, research recommends a concentrate to roughage (hay) ratio by weight of 8:1; or 200g per head daily pre-weaning.

Successful weaning of calves

Calf weaning age can vary from six to 10 weeks depending on the feeding strategy. Weaning decisions should be based on the calf's solid feed intake, not age *per se*. Once a calf is consuming 1.3% to 1.5% of its body weight as dry feed, this will provide sufficient nutrients body maintenance and growth. Calves should be consuming 1kg of calf starter per day for three consecutive days prior to ceasing liquid feed. To stimulate concentrate intake, the general advice is to reduce liquid feed consumption by 50% per day one week prior to desired weaning date. Monitoring starter intake, allows adjustment/delay of weaning dates for any calves not meeting growth targets/eating consistently well. Stressors, such as dehorning/vaccination, should be avoided during the weaning period.

Performance targets for the rearing period and first season at grass

Ruth W. Fennell¹ and John Barry²

¹Teagasc, Animal & Grassland Research and Innovation Programme, Johnstown Castle, Wexford

²Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork

Summary

- Calves should achieve a target live weight of 80 kg by eight weeks of age.
- ADG of 0.7-0.8 kg/day is required to achieve 12 week target weights of 100-105 kg.
- First housing live weight target is governed by the birth date of the calf (190- 230 kg).

Introduction

The calf rearing period can influence overall performance of dairy calf to beef enterprises. Fine margins exist in such systems, therefore, it is important to set objectives for the enterprise, and ensure that rearing protocols are designed to ensure these objectives are achieved. Post-weaning concentrate supplementation, parasite control and grassland management are key areas which ultimately determine animal performance, as well as performance of the enterprise overall.

What are the important targets for rearing dairy beef calves?

Farmers should aim to;

- ✓ Double calf birth weight by eight weeks i.e. 40 kg to 80 kg in 56 days.
- ✓ Achieve a growth rate of 700-800g/day.
- ✓ Calf mortality of less than 3% over the 12 week period.
- ✓ Less than 10% calf morbidity (incidences of disease)
- ✓ Achieve live weight of 120 kg by 15 weeks of age.

Ideally calves should be weighed at birth, or on arrival at the farm, and again between six and ten weeks. A weighing scales, weigh band (girth tape) or height stick can be used.

Targets for weaning

For successful weaning, the main target is to have calves eating at least 1kg calf starter/day for three consecutive days prior to weaning. This generally occurs by eight weeks of age, depending on the level of milk feeding, age at concentrate introduction and water availability.

Concentrate supplementation

From three days of age, a good quality, highly palatable coarse ration of 18% crude protein should be offered. Calves can be gradually moved from a coarse ration to a calf pellet after three to four weeks. At grass, a nut ration of 16% crude protein is sufficient providing grass quality is good. Spring born calves are turned out to grass shortly after weaning, however, if weather conditions are poor, calves may remain indoors for a number of weeks. In this case calves should receive 2 to 4 kg concentrate/day alongside hay or silage. At grass, early born calves are supplemented with 1 to 2 kg concentrate/day until mid-May. At this point, grass intake is increasing and concentrate supplementation is no longer required. Calves remain on a grass only diet until early September when they

will be supplemented once again with 1 kg concentrate daily until housing as grass supply and quality deteriorates. Calves born in April/May will go to grass later in the summer, and should receive 1 to 2 kg concentrate/day for the entire grazing period.

Targets for the first grazing season

During the first grazing season, target ADG for calves (bulls and heifers) is 0.80 kg/day. At housing, the live weight target for early spring born calves is 230 kg. For later calves (April/May born), this target is 190 kg at housing. Male dairy calves in a 15-month bull production system require an ADG of at least 0.90 kg/day during this period to ensure that they are approximately 250 kg at housing.

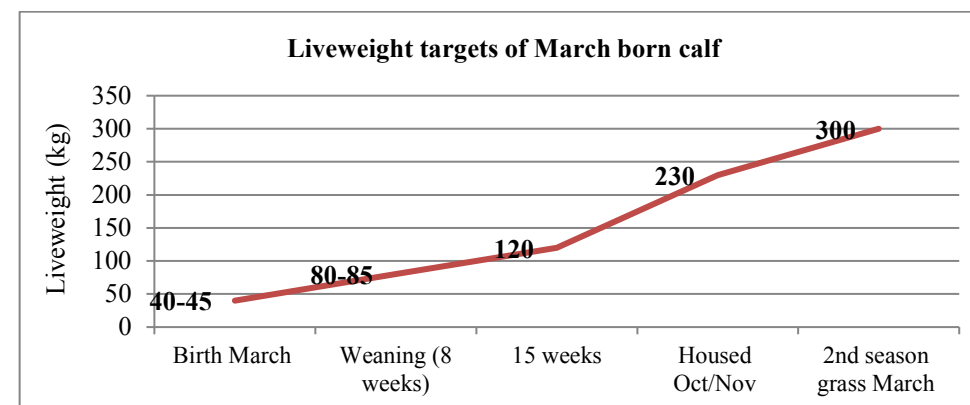


Figure 1. Target live weight of spring born calves from birth to turnout (second season).

Performance of 2018 born trial calves

For 2018 born calves on the Teagasc/ABP trial in Johnstown castle, average weight on arrival for Aberdeen Angus, Hereford and Limousin calves was 121 kg at 15 weeks of age, having gained 0.77kg/day during the rearing period on ABP Blade rearing farms. Due to the drought conditions (June to August), calves remained on 2 kg concentrate/day all summer, and were housed in November at 244 kg, having gained 0.83 kg/day in their first season. Calves were dosed regularly based on faecal egg counts, and performance was closely monitored.

Record keeping

Good record keeping is essential to evaluate the performance of an enterprise, and the following details should be recorded;

- Costs of all inputs – milk, milk replacer, meal, straw, hay etc.
- All stock purchases and sources.
- Cases of illness, treatments and cost.
- Performance of calves at various stages.

Analysis of these records allows farmers to compare their performance against key physical and financial targets, and identify areas for improvement.

Calf housing

Tom Fallon

Teagasc, Kildalton Agricultural College, Piltown, Co. Kilkenny

Summary

- Good ventilation, with no draughts, is crucial for calf houses to reduce dust, ammonia levels and disease
- Calves need dry, warm straw beds to perform optimally.
- Farmers should ensure that they design calf sheds carefully, with drainage/slopes being installed according to the feeding system/method being used.

1. Fresh Air

Good ventilation takes away moisture, dust, ammonia, bugs and excess heat. Dust and ammonia irritate the respiratory tract and make the animal more vulnerable to respiratory disease. The recommended minimum air inlet and outlet per calf is 0.08m². There should be no draughts (air speed greater than 0.5m/s) at calf level.

Natural ventilation is used in the vast majority of calf houses. This works in two ways:

1. 'Stack effect': warm air rises and leaves the building through an opening in the ridge and it is replaced by cooler, fresher air. A roof slope of 22° is a major help.
2. 'Wind effect': wind drives fresh air through the building.

Natural ventilation works best when the calf house is positioned at right angles to the prevailing wind and the building is not excessively wide (ideally less than 12m) or excessively high (3.35 to 4.0m at the eaves is recommended). Air inlets can be provided by 'Yorkshire boarding' or vented sheeting. Yorkshire boarding has two staggered lines of vertical timber so it reduces air speed, water entry and the likelihood of draughts. DAFM specification S101 stipulates that the minimum length of the boarding is 1.5 m, that the laths are 25 mm thick, a maximum width of 75 mm with gaps of at least 25 mm. The two lines of laths are 40 to 50 mm apart. Space boarding can be satisfactory on the sheltered side of a calf house in a suitable site. A capped ridge outlet is recommended with flashing to prevent wind driven rain getting in. Mechanical Ventilation can be used to substitute for inadequate inlets, but it is essential that outlets are adequate. Ventilation fans can draw fresh air from outside the building and blow it through a plastic duct with numerous small outlets along the length.



2. Space

Calves housed in groups require 1.8m² of pen area per calf but 2m² or more is preferable. Individual pens are generally not recommended since they add to the workload. Individual calf pens are 1.0m wide and 1.5 to 1.7m long. Calves must be able to see neighbouring animals and can't be kept in isolation unless there is a veterinary imperative.

3. Dry with good drainage

Calves spend 80% of their time lying down so they need a dry bed. A dry environment will also reduce the spread and growth of bugs. All calf houses should be built with a damp proof course to provide rising damp. A slope of 1:20 in the calf pen area is recommended (S124 DAFM). Split drains (see Figure 1) remove urine and associated smells out of the reach of calves quickly. This drain should be positioned 0.8m inside the feed barrier. In large pens, typically where automatic calf feeders are used, there is merit in having this drain approximately 3.0m within the pen. The front of the pen can fall into the channel so it will make it easier to achieve the 1:20 fall.

4. Warmth

Calves perform best at 15 to 20°C. Deep beds of straw are effective in protecting calves from the cold. Calves require 15 to 20 kg straw as bedding per week or one 150 kg round bale of barley straw to rear each calf. Breathable washable calf jackets are useful for a dry new born calf up to one month of age.

5. Clean & Cleanable

Floors and walls should be easily cleaned. Floors can be laid in bays of not more than 4.5m by 6.0m to avoid the need to make contraction joints. When the shed is emptied, clean out as soon as possible and completely clean with a power washer or steam cleaner and appropriate disinfectant. A long rest period will help to eliminate bugs.

6. Natural light

Natural light is conducive to good animal health and provides for a good working environment. It is recommended to have 15% of the roof area as translucent sheets.

Calf shed for teat, bucket or trough feeding

Figure 1 shows a calf shed that is suitable for a range of calf feeding methods. Each pen holds 10 calves, so a 12 teat calf feeder would be very suitable. Using 1.5m lengths of Yorkshire boarding (75 mm boards with 25 mm gaps and 40 mm between the rows) will give 0.18m² of inlet per calf. A ridge opening of 450 mm will give an air outlet of 0.11m² per calf. The split drain is positioned 0.8m inside the pen. The calves' feet should not be standing on the drain opening during feeding. It is not desirable to have a drain directly underneath feed troughs/buckets. There is no need for a canopy at the back of the pen when a suitable air inlet like Yorkshire boarding is used.

Figure 2 shows a suitable layout when calves are to be reared on an automatic calf feeder. Approximately 3.5m of the pen is not bedded. This facilitates a reduction in straw usage while allowing normal social behaviour among calves. Placing the split drain about 2.5m from the front of the pen helps to divide the fall across the shed (a 1:20 fall can be hard to achieve in practise). This non-bedded area has to be cleaned at least daily. This calf house can accommodate over 80 calves. Three training pens, each capable of holding three small calves, are included. A store with its own air space and access to receive a pallet of milk replacer is provided, as recommended by DAFM specification S124. Two of the calf pens

have small doors to allow calves access to a field, if desirable. It doesn't have to be a portal span; in fact using internal stanchions will reduce the cost of construction.

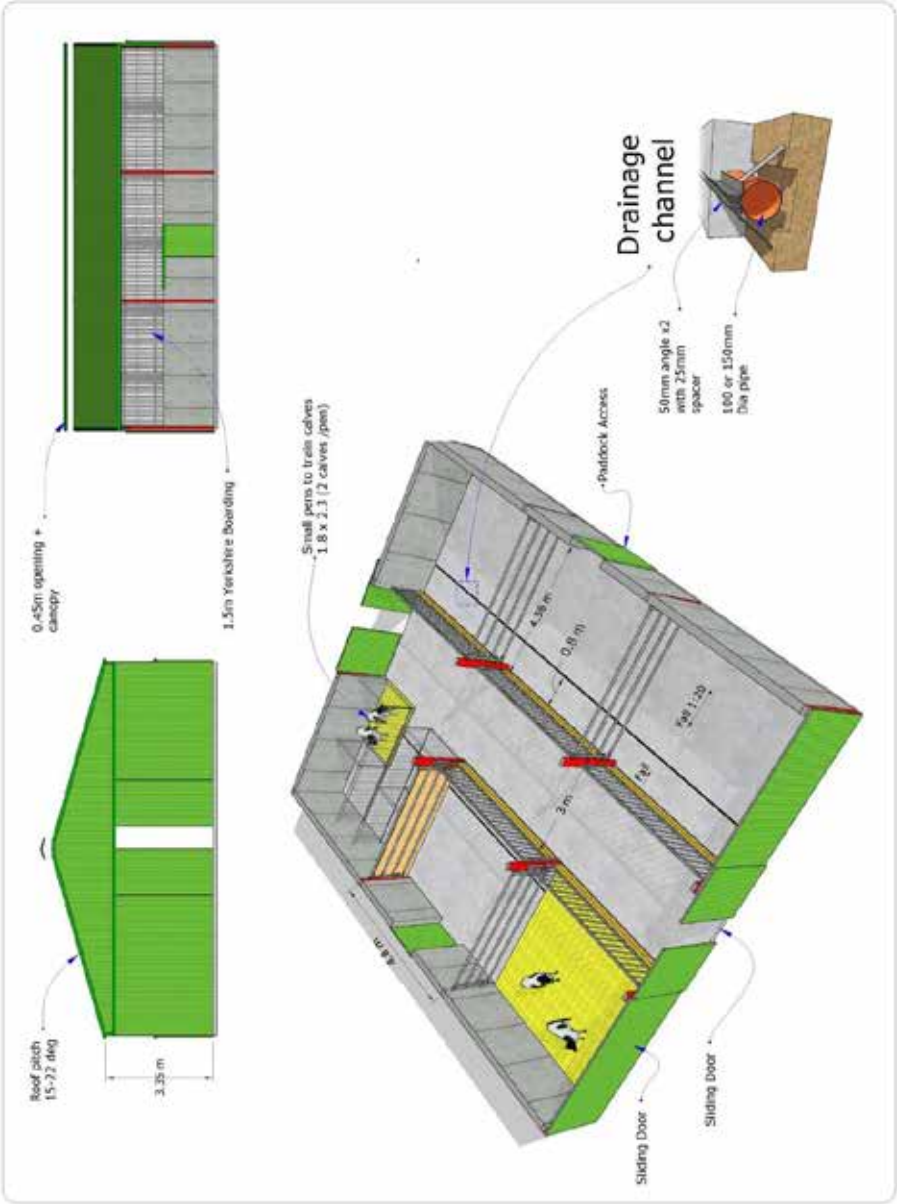


Figure 1. Calf house for teat/bucket feeding (10 calves per pen, 2.2 m² per calf)

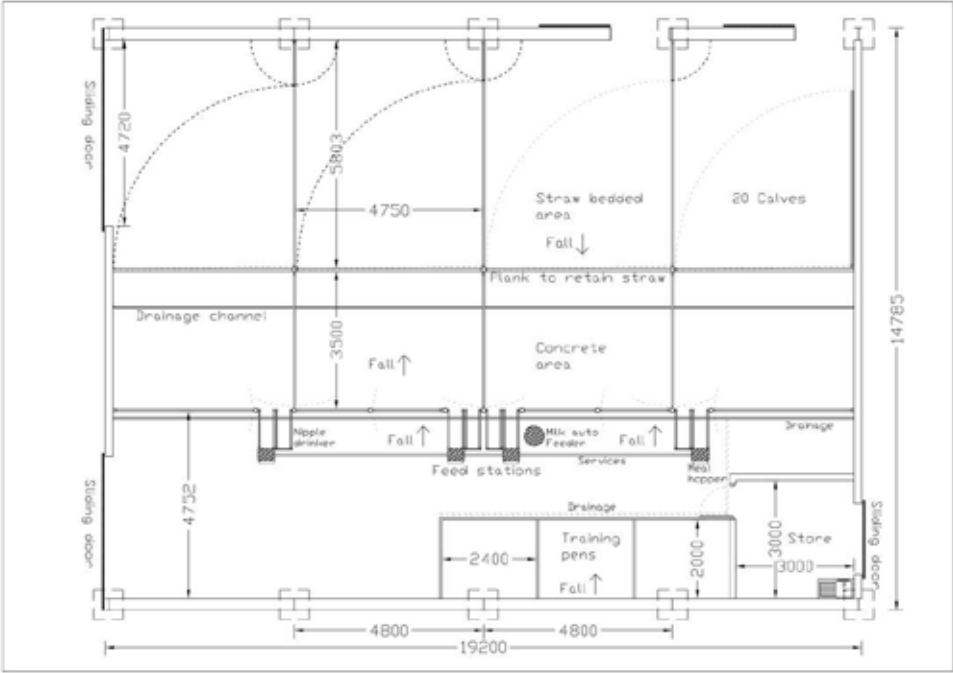


Figure 2. Calf shed suitable for an automatic calf feeder.

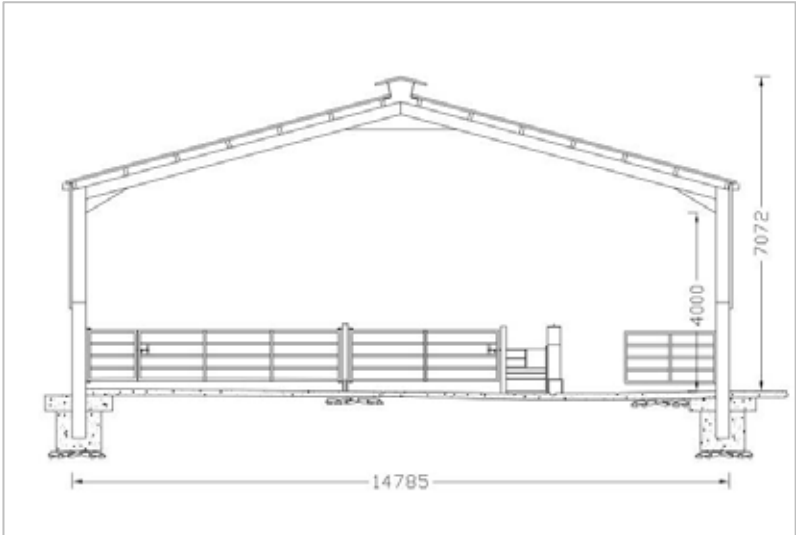


Figure 3. Cross section of calf shed suitable for an automatic calf feeder.

Health of dairy-bred calves

Aidan Murray
Teagasc, Knowledge Transfer, Drystock Department, Cavan Lower, Ballybofey, Co. Donegal

Summary

- A proactive approach to animal health on dairy calf to beef farms is needed.
- Good husbandry, housing and planned use of vaccination will help reduce the incidence of many scour and pneumonia outbreaks.
- We have to accept that our approach to animal health is going to change as we deal with on-going issues of antimicrobial resistance and anthelmintic resistance.

Introduction

With the continued expansion of the dairy herd towards 1.6m cows, one of the consequences will obviously be additional calves coming on the market. It has been predicted that by 2021 up to 900,000 calves will become available to either go for export or for the majority end up being finished on Irish farms. This will provide challenges on many fronts; from ensuring that we have first class health and welfare standards to facilitate live exports, to having systems in place on Irish farms that will allow these calves to thrive and leave a margin. In order to achieve good lifetime performance from these calves, good animal health protocols are required from birth through to slaughter.

Main Disease Risks

Calf Scours

A report released from the veterinary service of DAFM and DARD a few years ago revealed that up to 40% of calf deaths in the first six weeks are scour related. In a scenario where many of these dairy calves will arrive on farms from multiple sources, the ability to maintain a high level of biosecurity is diminished and therefore the risk of scour increases. If the dam has been vaccinated pre-calving, and the calf consumed adequate colostrum in the first 12 hours, the calf will have received a level of resistance against E. coli, rotavirus and coronavirus before it arrives on farm.

Table 1. Scour causative agents and typical age of infection

Calf Scours	Age (Days)
<i>E. coli</i>	1 - 5
<i>Cryptosporidium</i> A/B/C	0 -14
<i>Cryptosporidium parvum</i>	7 - 12
Rotavirus	4 - 21
Coronavirus	7 – 30

Cryptosporidium parvum is becoming more prevalent and, apart from the obvious lack of thrive and potential for high mortality rates, it is both expensive and time consuming to control an outbreak. It can also infect humans through cryptosporidium contaminated water supplies. There is no preventative vaccine. Calves from five to 35 days are susceptible, but it generally occurs in the second week of life. The infection will cause

severe damage to the lining of the gut wall and destroys the ability of the animal to absorb nutrients. Calves will become lethargic, stop drinking and can become dehydrated quickly. Once infected, after four days the calves will begin to shed vast quantities of oocytes in their scour. This leaves the environment heavily contaminated for other calves that then become infected. Rehydration therapy with milk and electrolytes and administration of preventative medication is required.

Coccidiosis tends to be seen in calves from about three weeks of age up to about six months. Infected calves pass out large numbers of oocytes which can contaminate the environment for other calves. The oocytes are resistant and can survive for long periods in the environment, for example in calf houses/sheds. Probably the biggest economic loss associated with coccidiosis is the poor thrive in animals that are affected. In many herds there may be sub clinical infection where animals show very little symptoms and will recover with time, however thrive and performance will be affected. In consultation with your vet, a planned prophylactic treatment programme may be necessary.

Treatment of calves with scour must involve rehydration, correction of acidosis, and replacement of electrolytes. In order to effectively correct acidosis, electrolyte products with an SID of at least 60mmol/litre are required. Research shows that products meeting this specification restore blood pH and base excess within a 12-18 hour period and facilitate a quick and full recovery of calves from scour.

Pneumonia

Pneumonia can be viral or bacterial in origin;

Viral	IBR, BRSV & PI 3
Bacterial	<i>Mannhaemia haemolytica</i>

Pneumonia is consistently the most commonly diagnosed cause of mortality in cattle greater than one month of age in DAFM regional veterinary labs. Non-fatal consequences of the disease are reduced weight gain, stunting and increased susceptibility to inter current infection. A planned vaccination programme, proper housing and good management practises will help mitigate potential outbreaks of pneumonia.

Health management of purchased calves:

- Purchased calves should be isolated from resident calves for at least one week.
- Continue to monitor their health status after arrival; treat any arising issues promptly.
- Housing must be dry, well bedded, ventilated and draught free and not over stocked.
- The first feed after arrival should be electrolytes.
- Within the first week of arrival, calves should be vaccinated against pneumonia and receive multivitamins.
- Always have clean fresh water available for calves.
- Have fresh concentrate available for calves from an early age to improve intakes, performance and reduce the stress at weaning.

Calf disbudding and castration – welfare implications

Bernadette Earley, Mark McGee, Edward G. O’Riordan and Gabriela Marquette
Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary

- The degree of tissue damage associated with disbudding is determined by the stage of development of the horn bud e.g. in younger calves the burning of the vessels surrounding the horn bud is sufficient, whereas the whole bud needs to be removed (by levering it out from the side) when the horn is further developed.
- Setting definitive ages for disbudding or dehorning is difficult since horn bud development occurs later in beef breeds than in the dairy breeds.
- Castration of bull calves induces a stress response (increase in the stress hormone, cortisol), which is influenced by the age of the calf.
- Castration-induced pain may be greater among younger calves compared with older calves because their nervous system and coping mechanisms (stress response) are not fully developed.

Introduction

Disbudding and castration of calves are two routine, and necessary, management practices performed to pre-empt future health and welfare problems. Disbudding is performed to prevent bullying and injury to other animals (with implications for productivity and carcass damage, respectively) as well as human safety during handling. Hot-iron (cautery disbudding) is the only method of disbudding allowed in Ireland under legislation (S.I. 127 of 2014); calves may be disbudded up to 28 days of age by thermal cauterisation. Local anaesthetic (LA) is required for disbudding of calves that are 15 days of age or older. Castration of cattle is performed in order to prevent sexual behaviour, reduce aggression, and increase handling safety. In Ireland, a calf can be castrated, by non-veterinary practitioners, before 6 months (mo) of age using a Burdizzo (castration device) or before 8 days of age using a rubber ring, without the use of local anaesthesia (LA) and or analgesia (pain killers). However, for calves older than 6 months, local anaesthesia, using a prescription only medicine (POM), must be administered by a veterinary practitioner to animals intended for castration.

Disbudding

In a recent Teagasc study, the effect of breed and age on horn bud size of 137 calves at the time of disbudding was examined. These comprised of 28 Charolais- (CH), 47 Limousin- (LM), 21 Simmental- (SI) sired suckler-bred calves, and 48 dairy-bred Holstein × Friesian (HF) calves. On the day (d) of disbudding, calves were moved individually to a disbudding crate and gently restrained. The diameter (mm) and height (mm) of the left and right horn buds were measured using a digital caliper (model 49-923-150; Linear Tools, UK). Cornual nerve blockade was achieved by injecting 2 mL of local anaesthetic (Adrenacaine) through the skin between the eye and the base of the horn bud on the left and right side of each calf. After 20 minutes had elapsed, calves were restrained in the

disbudding crate and the left and right horn buds were removed using a hot-iron disbudder. The disbudding sites were treated with an aluminium based aerosol spray after disbudding. The calves were retrospectively assigned to three age categories; 1) younger than 25 days old; 2), from 26 to 32 days old and 3), older than 33 days old.

There was no significant effect of calf gender or beef sire breed type on horn bud size (diameter and height) of calves at a similar age. Dairy calves had greater horn bud diameters (15.9mm) than beef calves (13.2mm). Dairy calves that were younger than 25 days of age had greater horn bud heights (6.2) than beef calves (4.2) of a similar age. Horn bud heights of dairy calves (6.7) were not different from beef calves (5.5) from 26 to 32 days of age. Dairy calves older than 33 days of age had greater horn bud heights (9.1) than beef calves (4.6).



Castration

A Teagasc study examined effect of age at castration on physiological stress indices in response to Burdizzo castration in dairy calves at 1.5, 2.5, 3.5, 4.5 and 5.5 months (mo) of age, without use of analgesia or anaesthetic. Castration was shown to raise the stress hormone, plasma cortisol concentration (nmol/L, in brackets), across all ages (1.5 mo (62), 2.5 mo (85), 3.5 mo (89), 4.5 mo (76) and 5.5 mo (116), for the first three hours after castration compared with the non-castrated/entire 5.5 mo old (35) ‘control’ calves. The lowest cortisol response was observed in calves castrated at 1.5-mo-old. There was no effect of castration on calf growth rate recorded over the following 6 weeks. The baseline surface skin temperatures of the lower left leg of each calf, and the reaction time (latency in seconds) to a heat spot laser on the left hind leg of each calf was measured pre- and post-castration. Calves at 1.5 mo-old had lower surface skin before castration, and had consistently lower skin temperatures than all other castrated calves throughout the study. At –72 h, the 1.5 mo-old calves had longer reaction time to the heat spot laser than older calves. In all calves, the reaction time increased after castration. In conclusion, the reaction time to the heat spot laser can be influenced by the surface skin temperature of the hind legs and the age of animals, particularly in calves less than 2mo of age which have lower skin temperatures and longer reaction time to the laser heat spot. Due to the differences in skin temperature between younger and older calves, and reduced pain sensitivity, the findings suggest that the younger calf may be physiologically immature and unable to respond to pain stimuli and raises the question whether castration of calves at a younger age could be more welfare unfriendly than castration at older ages.

Conclusion

Horn buds develop later in beef calves than dairy calves. Castration increases stress hormone concentrations (plasma cortisol) in calves; the greater the age at concentration, the greater the increase. Future work at Teagasc, AGRIC, Grange will examine the optimum age and application of local anaesthesia and or pain relief (analgesia) for the disbudding, and the castration of calves.

Widespread anthelmintic resistance on dairy calf-to-beef farms

Anne Kelleher^{1,2}, Theo deWaal² and Orla M. Keane¹

¹Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

²School of Veterinary Medicine, University College Dublin, Belfield, Co. Dublin

Summary

- Gut worm control is highly dependent on the availability of effective anthelmintics.
- Resistance to benzimidazole was found on 71% of farms tested, resistance to levamisole was found on 25% of farms, while resistance to macrocyclic lactone was found on 100% of farms for ivermectin and 75% of farms for moxidectin.
- Beef producers should implement sustainable worm control strategies that delay the further development of anthelmintic resistance.

Introduction

Grazing cattle are naturally exposed to gut worms. A variety of gut worm species infect cattle but the most common are *Ostertagia* which infects the abomasum (4th stomach) and *Cooperia* which infects the small intestine. Infection with these worms can cause scour and ill-thrift but more commonly results in appetite suppression resulting in reduced growth rates. Parasitic gastroenteritis caused by gut worms is primarily a disease of first season grazing cattle and is often more common in the second half of the grazing season due to the build-up of larvae on pasture. After their first grazing season, cattle commonly develop sufficient immunity to prevent clinical disease but heavy infections can still reduce performance. Occasionally, larval development subsides and the larvae over-winter in the animal and re-emerge the following spring causing type II *Ostertagiosis*.

Worm Control

Control of gut worms is usually achieved by the administration of broad-spectrum anthelmintics. There are a large number of products licenced for the control of gut worms in cattle; however they fall into a smaller number of drug classes (Table 1).

Table 1. Anthelmintic classes for the control of gut worms in cattle.

Anthelmintic Class	Common name	Route	Stages affected
Benzimidazole	White (1-BZ)	Oral	Eggs, larvae, adults
Levamisole	Yellow (2-LV)	Oral, inject, pour on	Adults
Macrocyclic lactone	Clear (3-ML)	Inject, pour on	Larvae, adults

The widespread use of anthelmintics has resulted in the emergence of anthelmintic-resistant gut worms. Anthelmintic resistance refers to the ability of worms to survive a dose that should kill them. Anthelmintics from different classes have different modes of action. However, within the same class all products share a mode of action and so when resistance develops to one product within a class all products in the same class are generally also affected. Anthelmintic resistance can be diagnosed on-farm by a faecal egg count reduction test (FECRT). A fully effective anthelmintic dose reduces egg count to zero after administration. If the egg count reduction is less than 95%, then anthelmintic resistance is considered to be present.

Anthelmintic Resistance Trial

A study was carried out on 24 dairy-beef farms in Ireland in 2017 and 2018 to determine the prevalence of anthelmintic resistance. The worm burden of each herd was monitored and a FECRT conducted when sufficient worm challenge was present. The results are shown in Table 2.

Table 2. Results of the FECRT carried out on 24 dairy-beef farms.

Anthelmintic Class	Number of farms tested	Number of farms with resistance	Prevalence of resistance
Benzimidazole	17	12	71%
Levamisole	12	3	25%
Macrocyclic lactone (ivermectin)	17	17	100%
Macrocyclic lactone (cydectin)	12	9	75%

Strategies to manage gut worms

It is important that beef producers implement sustainable strategies to manage gut worms and to delay the further development of anthelmintic resistance. Determining which of the anthelmintic classes are effective on the farm is a good first step. Consult your vet or agricultural advisor on how to do this. When considering anthelmintic treatment first establish whether the group requires dosing. Young stock should be monitored for signs of clinical disease such as scour and failure to thrive. Worm burden can also be monitored using faecal egg counts. In calves, a faecal egg count of more than 200 eggs per gram may indicate a need to treat for gut worms. It is very important that the correct dosing technique is used and that the animals are treated according to the manufacturer's instructions and dose rates. The dosing equipment should be checked before treatment to ensure it is delivering the correct amount. The animals should be weighed, or a few of the biggest animals in the group selected and weighed, to determine the dose rate and all dosed to the weight of the heaviest animal. Continual use of anthelmintics from the same class should be avoided and a combination anthelmintic products (flukicide + wormer) only used when it is necessary to target both fluke and worms. Where possible keep the cleanest grazing, such as forage crops, reseeded ground or hay/silage after grass, for the most naïve animals. Calves can also be grazed ahead of older animals or mixed with sheep to reduce the worm challenge. A good biosecurity protocol for all bought-in animals should be implemented to prevent bringing resistant worms onto the farm. Bought in stock should be treated with an anthelmintic and housed for 48 hours. They should then be turned out to contaminated pasture recently grazed by cattle.

Conclusion

Early detection of anthelmintic resistance and the implementation of sustainable worm control strategies are required in order to protect animal health and prolong the life of the current anthelmintics.

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Sustainable Grassland Management

Growing your potential; Grass-to-Beef

Nicky Byrne¹, Donall Fahy¹ and Michael O'Donovan²

¹Teagasc, Grange, Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

²Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

Summary

- Profitable calf-to-beef production is based on utilising large quantities of grazed grass to produce quality beef at low cost.
- Stocking rate is dependent on the farms ability to grow and utilise grass.
- Early spring grazing is necessary to promote increased sward and animal performance.
- Grazing infrastructure will help maximise grass utilisation.
- To increase grass utilisation, pre-grazing herbage mass, post-grazing sward height and rotation length need to be well managed.
- Grass measurement and budgeting are key elements of grazing management.

Introduction

The implementation of grass-based production systems will ensure the economic and social sustainability of drystock farms. Ireland's comparative and competitive advantage as a beef producer arises from the ability to grow and utilise grass. Grazed grass is the cheapest source of energy for ruminants and is capable of supporting high levels of animal performance. Beef systems implementing high levels of grassland management to support improved animal performance and output/ha have a lower carbon footprint per kg of beef produced. Such systems have favourable animal welfare, as cattle have free access to pasture over an extended grazing season ranging from 250 to 300 days across the country. These competitive advantages differentiate Irish beef products, helping gain access to some of the highest value and specification markets in the world.

Nationally beef farms are lowly stocked at 1.1 LU/ha, but there is considerable scope to increase stocking rate across beef systems depending on the farms ability to grow and utilise grazed grass (Table 1). Nationally across drystock farms grass utilisation is low at an estimated 5.6 t DM/ha, which is only 58% of its potential. To maximise grass production and utilisation grazing management, soil fertility, drainage, paddock infrastructure and sward composition need to be optimised and better managed on farms. Calf-to-beef systems need to focus on maximising output/ha using minimal imported feed, targeting 80% of animal's lifetime feed requirement coming from grass and silage. Central to the success of calf-to-beef systems is regular measurement and management of grass to ensure its supply and quality throughout the grazing season.

Table 1. Farm stocking rate, based on growth and utilisation potential.

	Tonnes DM/ha grown			
	15.0	12.0	9.0	6.0
t DM/ha utilised	11.3	9.0	6.8	4.5
Stocking rate LU/ha	2.6	2.0	1.5	1.0

*80% forage diet (4.4 t DM/LU), at a 75% herbage utilisation.

Grazing infrastructure

Good grazing infrastructure (paddocks, roadways, water, etc.) is necessary to maximise grass growth, utilisation and to help maintain sward quality whilst reducing labour. On many drystock farms, the number of paddocks is inadequate resulting in a long residency time (greater than 72 hours). The result of this extended residency time is reduced grass utilisation as cattle will opt to graze regrowth. This will lead to reduced DM production and sward quality, delayed fertiliser application and ultimately poor animal performance. The grass plant can only support three actively growing leaves; if a fourth emerges the oldest leaf will begin to die reducing sward quality. During the mid-season it takes seven days for a grass leaf to appear. To strike a balance between quantity and quality the optimum time to graze is when the plant has 2.5 to 3 actively growing leaves. The number of days it takes to reach the three leaf growth stage should determine your farms rotation length; this is typically 21 days during the mid-season (3 leaves × 7 days). To determine the number of paddocks needed on your farm divide rotation length by the desired residency time.

$$21 \text{ days} \div 2 \text{ day residency time (48hr)} = 12 \text{ paddocks per animal group}$$

Forty eight hour paddocks offer flexibility as animals don't have to be moved as often and are less restricted, large enough for machinery operations and they can be split temporally in times of difficult grazing conditions. The size of the paddock should be determined by the demand of your grazing group. To calculate the size of your paddocks you will firstly need to know the daily demand of your herd. Typically calf-to-beef animals are allocated approximately 2% of their bodyweight on a daily basis. Paddocks should be grazed at a target of 1300 kg DM/ha. An example of a herd of 50 steers, weighing 420 kg is as follows;

$$(420 \times .02 = 8.4 \text{ kg DM/day}) \times 50 \text{ steers} = 420 \text{ kg DM daily demand}$$

$$420 \text{ (daily demand)} \div 1300 \text{ (cover)} = 0.32 \text{ ha needed daily}$$

$$\text{48-hour paddock} = 0.65 \text{ ha}$$

Access to paddocks is important, particularly during the shoulders of the grazing season. A road network will facilitate an extended grazing season and management of livestock. The specification of farm roadways will be determined by their intended use and level of traffic. On many farms grass tracks/spur roadways serviced by a main gravel roadway are sufficient, as the level of traffic from cattle grazing 48-hour paddocks would be far less than that experienced on dairy farms.

Grazing management for calf-to-beef systems

Increasing grass growth with early spring grazing

Spring grass is highly digestible, high in protein and DM content and will support higher animal performance, with each kg DM having 1.03 UFV. Dairy calf-beef systems must be focused on utilising early spring grass, to achieve higher animal performance and displace concentrate use. Calf-to-beef systems are in a good position to start grazing early in the spring as yearlings are relatively light (300 to 330 kg) minimising sward damage and they will have a low grass DM demand initially. Aside from direct animal benefits, swards grazed in spring (February to early April) have higher growth rates throughout the year

compared to swards ungrazed during this period. Previous research comparing early versus late turn-out 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). Most beef farms in Ireland are finishing the first rotation too late and are losing out on the benefits of early spring grass. If calf-to-beef farms don't start grazing early in the spring this is likely to occur as grass demand will be low, pushing out the start of the second rotation, this will also be compounded by higher production costs during the early half of the spring.

The aim in spring is to increase the proportion of grass in the diet of the grazing animal while at the same time budgeting to ensure sufficient grass until the start of the second grazing rotation in early April. Spring grazing should start in February/March and continue until early April. Farmers can control demand by gradually turning out priority stock (lighter cattle) from an early stage in the spring to ensure sufficient grass until the start of the second rotation. The end of the first rotation varies from farm to farm. If turnout 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 less than 4 cm will be difficult as utilisation will be reduced. As part of the dairy calf-to-beef systems trial at Teagasc Grange, yearling steers were turned out to grass on February 12th. From turnout to April 1st across Angus and Holstein Friesian group's average daily gain was 1.10 kg/head/day, grazing covers of 1435 kg DM/ha to a post-grazing height of 3.5 cm. Cattle had to be rehoused for two weeks during this period due to poor grazing conditions.

Spring grazing management

Average farm cover at turnout should be 600 to 700 kg DM/ha. The spring rotation planner should be followed, with an aim of having 30% of the farm grazed by the March 1st, 60% by March 17th and first rotation complete by April 1st, on heavy soils these targets can be reduced by 10% for the respective dates. During the first rotation it is critical to graze paddocks tightly, targeting a post-grazing height of 3.5 to 4 cm. This will condition the sward removing any dead material accumulated over the winter, stimulating new leaf growth, improving sward quality in subsequent grazing rotations. Quality grass silage greater than 72% DMD is critical for calf-to-beef systems, thus it is important to get silage swards grazed before closing. Silage ground should be closed by the first week in April. Calf-to-beef farms should be aggressive with first cut silage, closing 50 to 60% of the farm area. This is important as demand grows from a low base across the year, peaking in the late summer/autumn reducing the area available for second cut silage. Closing a large proportion of the farm will also condition the sward with leafy after-grass ideally suited for calves.

Mid-season grazing management

The main challenge mid-season is to maintain sward quality as grass goes through the reproductive growth stage. Weekly farm cover



measurement is critical at this point as grass growth is high requiring a rotation length of 18 to 21 days and maintaining pre-grazing covers of 1300 to 1600 kg DM/ha and a post-grazing height of 4 to 4.5 cm. From grass budgeting farmers can identify when growth will exceed demand requiring paddocks to be skipped and removed as high quality baled silage. These paddocks once exceeding target grazing yield should be taken out as early as possible and not allowed bulk up as this will reduce their regrowth capacity, creating the risk of a grass deficit occurring later. Calves should have access to leafy swards throughout the grazing season, after-grass will satisfy this but when that becomes too strong, a leader follower system should be adopted, allowing calves graze ahead of older cattle on the farm, giving them more selection and not forced to graze out swards. This process will optimise sward utilisation and calf performance through high intakes of digestible leaf whilst minimising parasite challenge.

Autumn grazing management

Planning for spring begins the previous autumn as the majority of grass available for early grazing has been grown over the autumn/winter months. The feed value of autumn grass is less than that of spring grass so there are many advantages to preserving its supply for the following spring when higher levels of animal performance are achievable. To do this farms have to start building farm cover by slowing down the grazing rotation from August 10th, extending it by 10 days/month until mid-October when rotation length reaches 45 days. This will mean grazing pre-grazing covers of 2000 to 2300 kg DM/ha. Grass has to be budgeted over the autumn to allow animals remain outdoors until mid-November. The 'Autumn 60:40 planner' is a simple tool used to manage grass supply, outlining the farm area which needs to be closed by set dates to ensure sufficient supply in spring, whilst allowing animals graze late into the autumn. The general rule of thumb is to start closing paddocks between October 5th and 10th, and have 60% grazed by November 7th and 100% grazed by December 1st. On heavier soils these dates can be at least two weeks earlier. Research has shown that every day delay in closing after October 10th spring-grass supply is reduced by 15 kg DM/ha. At housing the average farm cover should be in the region of 500 to 600 kg DM/ha. Dairy calf-to-beef systems DM demand peaks in the autumn making it difficult to build farm cover. Demand needs to be reduced which can be done by introducing concentrates into the diet of finishing cattle or housing them on a finishing diet of silage and concentrate, allowing lighter weanlings enjoy an extended grazing season whilst building farm cover. This will also take pressure off housing and slurry storage facilities as in a 21 to 24 month system a large proportion of cattle will be slaughtered by the time weanlings are housed.

Conclusion

Dairy calf-to-beef systems must focus on output/ha, optimising animal performance from a grass-based diet (80%). Each farm is different and stocking rate should be dependent on the ability to grow and utilise grass with minimal imported supplement. To achieve this, farms must be set up for grazing, with good paddock and roadway infrastructure to aid in grassland management. Grass measurement and budgeting is important to ensure the supply and quality of grass throughout the grazing season.

Quality silage in calf-to-beef systems: importance of getting it right

Brian Garry
Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

- Summary
- Calf-to-beef systems require good quality silage of 72-74 DMD.
 - Target four bales per weanling, seven bales per yearling for a 120 day housing period.
 - Harvest silage before/ at seed head emergence – do not delay, quality reduces rapidly.
 - Reduce cost of producing silage by reducing feed out and ensiling losses.

Introduction

Grazed grass, grass silage and concentrate are the main feed inputs on beef farms, and collectively account for over 70% of direct costs. Within dairy calf-to-beef systems, they account for 55, 24 and 21% of feed DM intake, but for 31, 29 and 40% of feed costs respectively. To reduce feed costs, cattle should only be offered high quality forage. Results from silage analyses on drystock farms show silage quality was, on average, 66 DMD, which only is adequate for dry suckler cows. Given the large winter feed costs in calf to beef systems; livestock performance can be improved while reducing costs by feeding high quality forage. This paper will outline the main issues for consideration when planning grass silage for a calf to beef system. The objective of any silage system should be to provide sufficient forage, reduce requirement for additional feedstuffs, minimise losses and to ensure adequate animal performance for the duration of feeding over the winter period. A plan should deliver on three key principals:

- A good yield of first cut silage, with a high annual tonnage produced per hectare.
- Silage that is free of contamination, low ensiling losses, well preserved with good intake characteristics.
- Appropriate forage quality relevant to the type of livestock being fed.

Table 1. Effect of silage quality (DMD) on live weight gain of beef cattle.

DMD	75	70	65
Harvest date	20 May	2 Jun	15 Jun
Yield (t DM/ha)	4.5	6.0	7.0
Intake (kg DM/day)	9.0	8.3	7.6
Liveweight gain (kg/day)	0.83	0.66	0.49

For calf to beef systems, silage quality should be targeted at 72 to74 DMD. As weanlings have a low intake capacity, these high quality silages, which have a lower fill value, allow greater intakes and performance from silage, resulting in less concentrate being required to meet growth targets (Table 1). Each weanling will have, on average, a DMI of 6 kg. For a 120 day winter this will work out at 720 kg DM silage per weanling. When losses at ensiling and feed out are accounted for, assuming on farm management is good, each

weanling will require four bales of silage. To have 200 bales for 50 weanlings of high quality silage, a target yield of 4000 kg DM/ ha would yield 15 bales/ ha (6 bales/acre) when wilted. This would require 14 ha or 35 acres to be harvested to meet this requirement. Store these bales separate other bales on farm so they can be fed to priority stock. Given the lower yield of the crop, it may be more cost effective to harvest silage as bales to reduce costs. Facilities on farm (only one silage slab), contractor availability, ease of management and practicality should be considered before deciding on pit or bales.

Silage quality

High quality silage is more than just well-preserved silage. The quality of harvested swards depends on its growth stage – leafy grass has a much higher energy value (DMD) than stemmy grass with mature seed-heads. The species and varieties of grass, and the presence of weeds, also impact on DMD. Together with weather conditions, fertiliser (including slurry) application rate and timing can influence the ensilability of the harvested grass. The balance between grass yield and DMD is achieved by harvesting ryegrasses when their seed heads start to emerge. The relationships between growth stage and DMD can be misaligned if other issues which effect DMD are present. For example, the presence of a build-up of dead material at the base of the sward will reduce DMD. Dead vegetation can have a DMD below 50%, which can therefore reduce silage DMD by 6 to 7% by a harvest date in mid-May. It would take 2 kg concentrate per head daily to undo the impact of this scale of reduced DMD. Sward regrowth needs to start from a ‘bare stubble’ when they are to be used for producing high DMD silage.

Preserving silage and minimising losses

Silage quality and quantity losses occur during ensiling. For every 1000 kg grass DM in a silage sward, between 150 and 300 kg losses can occur. Furthermore, the DMD of ingested silage can be 0-7% units below the cut sward. These losses occur in the field (leaf shatter, incomplete pick-up, etc.), at the silo (respiration losses, effluent, etc.) and in the feed trough (respiration, spillage, etc.). Some losses are unavoidable but others can be reduced or prevented. For example, a sward yielding 6000 kg grass DM/ha produces 5040, 4620 and 4200 kg edible silage DM/ha where losses of 16% (excellent management), 23% (good management) and 30% (poor management) occur, with quality losses of 0, 1.5 and 4% units DMD respectively. The yield loss difference between 16 and 30% DM loss results in over 80 fewer animal feed days/ha. The DMD loss difference of 0 vs. 4% units DMD requires over 1 kg concentrate/animal daily to undo. Thus, DM losses of 16, 23 and 30% (+ DMD loss) result in costs of €207, €230 and €263 to provide cattle with feed energy (1000 UFL) as silage.

These values show the importance of management practices that reduce losses during silage production and feed out. They include efficient mowing and pick-up, effective wilting during good drying weather, fast filling and perfect sealing of the silo, ensuring good fermentation and relatively little effluent, fast and tidy feed-out, and sensible feed provision and waste removal at the feed trough. Care should be taken to inspect silos and bales to identify holes and repair as necessary.

Efficient use of cattle slurry

David Wall and Mark Plunkett

Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

Summary

- Target slurry application to fields with low soil test P and K results (Index 1 and 2).
- Cattle slurry is a very suitable and balanced source of N-P-K for silage fields.
- To maximise N recovery apply slurry in spring time or on cool, overcast days.
- Switching slurry application from summer to springtime will increase the N value by approximately three units per 1,000 gallons for cattle slurry.
- Using low emission slurry spreading (LESS) application methods will also increase the slurry N value (three units per 1,000 gallons) and reduce ammonia emissions.

Introduction

Slurry is an important source of N, P and K and its effective use is essential to balancing soil fertility levels. To maximise the nutrient value of cattle slurry and reduce N loss to the air, a number of decisions must be made. Firstly, *where* on the farm should slurry be applied to maximise slurry P and K? Secondly, *when* is the most efficient time to apply slurry to maximise N recovery?

Targeted application of slurry based on soil test results will ensure efficient use of early-season P and K in satisfying grass requirements. The typical value of 1,000 gallons of cattle slurry applied by trailing shoe or band spreader in springtime has an available N-P-K content equivalent to a 50 kg bag of 9-5-32. For example, an application of 1,000 to 2,000 gals/ac of either slurry will supply sufficient N, P and K for early grass production. The nutrient content of slurry will vary according to its dry matter and with slurry dilution with water. Knowing the nutrient content will help ensure that the correct quantities of nutrients N, P and K are applied according to what is planned. Typical manure values are shown in table 1 but nutrient levels can vary widely. A practical approach to estimate the slurry dry matter slurry after agitation is using a slurry hydrometer. This is a low-cost and useful tool to estimate the N-P-K value based on slurry dry matter.

Phosphorus (P) & Potassium (K)

Cattle slurry is an excellent source of P and K fertilizer 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 or maize silage. Targeting these areas will help reduce fertilizer 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 tend to be the furthest fields away from the yard and tend to have low P and K levels plus the biggest nutrient demand. Slurry is a valuable fertilizer and the value of the nutrients present (approximately €24 per 1000 gallons) will more than offset the cost of transporting slurry to fields that may be further from the farm yard, or to outside silage blocks, in most cases. The P to K ratio (around 1:6) in cattle slurry is more suitable for grass silage crops. The P in organic manures is 100% available relative to chemical

fertilizer at soil P index 3 and 4. However, when applied to low fertility soils (P Index 1 or 2) the availability of the P is estimated at 50%. Therefore, aim to apply 50% of crop P requirements in the form of slurry P to index 1 and 2 soils and top up the remaining 50% with bag fertilizer P. Check soil sample results and the fertilizer plan to identify low P fertility fields and farm P limits.

Nitrogen Content

The form of N in cattle slurry is ammonium-N and is readily available for plant uptake provided soil and weather conditions are favourable. Losses of slurry-N to the air can occur when slurry is applied during drying weather conditions such as warm, sunny and windy days. To maximise the N availability from slurry, it should be applied on cool, overcast or misty days. It is recommended to apply slurry in the springtime. Spring applied slurry is worth approximately 3 units of N per 1,000 gallons extra compared with summer application (see table 1). Regardless of timing, applying slurry in the right weather conditions (cool, overcast conditions) is advised to maximise the N availability.

Table 1. Typical available N, P and K values (kg/m³) for slurry using a splash plate.

Application Technique - Splash plate				
Cattle Slurry (7% DM)				
Time of Application	N kg/m ³ * (units/1,000gal)	P kg/m ³ (units/1,000gal)	K kg/m ³ (units/1,000gal)	€/m ³ (€/1,000gal)
Spring	0.7 (6)	0.5 (5)	3.5 (32)	€4.3 (20)
Summer	0.4 (4)	0.5 (5)	3.5 (32)	€3.9 (18)

Slurry Application Equipment

Using low emission slurry spreading (LESS) methods (i.e. band spreader/trailing hose or trailing shoe) will reduce N losses at slurry spreading time and increase N availability for grass compared to the splash-plate method. The trailing shoe places the slurry in lines below the grass canopy where it can move into the soil quickly while the band spreader places the slurry in narrow bands on top of the grass. Both of these methods reduce the surface area spread and the slurry's exposure to drying conditions and thus the risk of N loss (see table 2). Other benefits include (1) reduced contamination of herbage leading to quicker return to grazing, (2) the opportunity to apply slurry into higher grass covers and (3) more even application of slurry across the spread width. The odours released during and after application may also be reduced.

Table 2. Typical available N, P and K values (kg/m³) for slurry using a trailing shoe.

Application Method - Trailing Shoe / Band Spreader				
Cattle Slurry (7%DM)				
Time of Application	N kg/ m ³ (units/1,000gal)	P kg/m ³ (units/1,000gal)	K kg/m ³ (units/1,000gal)	€/m ³ (€/1,000gal)
Spring	1.0 (9)	0.5 (5)	3.5 (32)	€4.6 (21)
Summer	0.6 (5)	0.5 (5)	3.5 (32)	€4.2 (19)

Choosing the correct varieties to drive paddock performance

Tomas Tubritt^{1,2} and Michael O'Donovan¹
¹Teagasc Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork
²The Institute for Global Food Security, Queen's University Belfast, Belfast, N. Ireland

Summary

- Key traits in the PPI are seasonal dry matter (DM) yield, grass quality, silage yield and persistency.
- The relative emphasis on each trait is as follows: grass DM yield (31%), grass quality (20%), silage yield (15%) and sward persistency (34%).
- There is a large range in PPI values (€/ha/year) between the highest (€214) and lowest (€66) varieties.
- Farmers will need to carefully choose varieties appropriate for their requirements when using the PPI.

Introduction
Food Wise 2025 has set a target to increase grass utilisation nationally 2 tonnes dry matter per hectare (DM/ha) annually by 2025. This target will be difficult to achieve without an increase in reseeding to generate new more productive ryegrass/white clover swards. The Pasture Profit Index (PPI) was introduced to the Irish grassland industry in 2013, after many years of focussed research and refinements to Department of Agriculture, Food and the Marine evaluation protocols. The PPI sets out in economic terms, the agronomic differences between traits of grass varieties, to allow farmers to select the most appropriate varieties for their particular purposes. It is also essential that farmers and the industry only use or retail recommended listed material as this is the most reliable quality control for grass varieties.

Approach used
The use of the PPI enables the identification of grass varieties which provide the greatest economic contribution to a ruminant grazing system. The index ranks grass varieties based on their economic benefits and will ultimately result in an increase in the use of superior varieties, which means higher profitability for the industry. The key traits in the PPI are seasonal DM yield (spring, summer and autumn), grass quality (DM digestibility, DMD), silage yield and persistency. These are referred to as sub-indices in the total index. The sub-indices identify the relative strengths and weaknesses of individual varieties. All varieties on the PPI Recommended List now have a minimum of two years agronomic data generated before the PPI is calculated. The range in PPI for varieties on the Recommended List in 2019 is from €214 to €66/ha/year. The data generated in the PPI is from the Department of Agriculture, Food and Marine evaluation protocols. The relative emphasis on each trait is as follows: grass DM yield (31%), grass quality (20%), silage yield (15%) and sward persistency (34%). The base values that are used are spring DM yield = 1.13 t DM/ha, mid-season DM yield = 7.02 t DM/ha and autumn DM yield = 2.32 t DM/ha. Base values for grass quality is 840.8 g/kg DMD. The base value for first and second-cut silage is 4.6 t and 4.01 t DM/ha respectively. Persistency is based on ground

score (GS) change (GSA). The economic merit for persistency was determined by dividing the cost of reseeding (assumed to be €672/ha) by the number of years a variety persists. Varieties surviving the yield threshold of 12 years or longer are assigned a value of 0 and less-persistent varieties are assigned a negative economic value. In so doing, the PPI rewards varieties with a low GSA and consistently high levels of DM production. The sub-indices present the opportunity to select varieties for specific purposes. Desirable traits for each individual system are displayed in Table 1.

Table 1. Desirable variety traits for grassland systems.

Grazing swards	Silage swards	Mixed swards
Similar heading dates (6 days)	Similar heading dates (4 days)	Similar heading dates (6 days)
50% tetraploids (less on heavy soil)	40% tetraploid	50% tetraploids (less on heavy soils)
High quality index	High silage index	High quality index
Good seasonal growth + Clover	High spring growth	High silage index

Grazing efficiency
Grazing efficiency is a trait currently being evaluated by Teagasc. Varieties showing good grazing efficiency are desirable as they are grazed tightly by cows, they maintain their quality throughout the season and they reduce the need to top fields. This research has identified that tetraploids have improved grazing efficiency over diploids and thus increased proportions of tetraploid varieties should be sown on grazing swards. Increased levels of OMD and increased leaf proportion are shown to improve the graze out performance of grass swards. Figure 1 shows the level of OMD for each variety trialled in Teagasc Moorepark over the past two years. As can be seen from Figure 1, tetraploids excel in these characteristics relative to diploids. Into the future grazing efficiency will be included as a trait within the PPI.

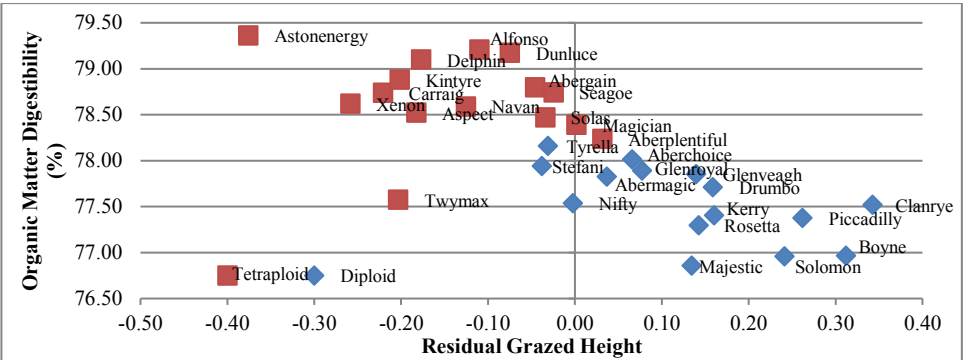


Figure 1. The relationship between levels of Organic Matter Digestibility and graze-out.

Table 2. Pasture Profit Index values for recommended listed varieties in 2019.

			Pasture Profit Index Values € / Ha / Year						
Variety Name	Ploidy	Heading Date	Total	Sub-Indices					
			PPI	Spring	Summer	Autumn	Quality	Silage	Persist.
Abergain	T	4-Jun	214	37	40	43	56	37	0
Aberclyde	T	25-May	205	54	43	34	44	30	0
Abermagic	D	29-May	197	44	46	70	19	17	0
Nifty	D	27-May	193	80	50	57	-23	29	0
Fintona	T	22-May	191	73	23	43	12	40	0
Aberchoice	D	9-Jun	189	32	45	51	47	15	0
Moir	D	24-May	187	118	21	49	-30	29	0
Abergreen	D	31-May	182	58	52	62	4	6	0
Aberplentiful	T	8-Jun	182	57	44	42	17	22	0
Elysium	T	25-May	171	73	30	26	19	22	0
Dunluce	T	29-May	170	31	39	45	25	31	0
Aberwolf	D	29-May	169	65	33	34	14	23	0
Meiduno	T	3-Jun	167	55	39	41	16	22	-5
Astonconqueror	D	25-May	165	79	29	34	-4	27	0
Gusto	D	30-May	161	67	31	55	15	-7	0
Briant	T	3-Jun	157	37	39	39	19	24	0
Rosetta	D	23-May	156	85	25	40	-16	22	0
Seagoe	T	26-May	155	45	35	36	-1	40	0
Aberbite	T	1-Jun	154	10	38	44	39	34	-11
Ballintoy	T	2-Jun	150	31	35	35	22	28	0
Triwarwic	T	2-Jun	139	42	34	23	13	27	0
Kintyre	T	6-Jun	134	25	33	50	5	22	0
Astonenergy	T	2-Jun	132	9	30	36	48	10	0
Solas	T	10-Jun	131	16	31	50	10	24	0
Xenon	T	8-Jun	128	18	31	30	29	20	0
Aspect	T	6-Jun	124	20	32	24	32	16	0
Oakpark	D	2-Jun	118	34	30	33	-8	28	0
Drumbo	D	7-Jun	117	29	27	34	24	3	0
Astonking	D	5-Jun	116	64	28	22	-15	17	0
Alfonso	T	1-Jun	113	7	30	34	34	8	0
Smile	D	5-Jun	101	24	25	43	-6	14	0
Kerry	D	2-Jun	98	42	31	35	-23	13	0
Glenroyal	D	4-Jun	96	25	32	40	-11	12	0
Clanrye	D	6-Jun	68	27	31	15	-30	25	0
Majestic	D	1-Jun	66	35	26	36	-38	7	0



Grassland P and K planning on drystock farms

Mark Plunkett and David Wall

Teagasc, Environment, Soils and Land Use Programme, Johnstown Castle, Co. Wexford

Summary

- P & K requirements are low on drystock farms.
- Aim to apply 50% of P in springtime.
- Additional P is available to build soil P levels to optimum Index 3.
- Prepare a fertiliser plan annually for efficient use of applied nutrients.

Introduction

Good soil fertility is an essential ingredient on grassland soils which is a key driver of season long grass growth. However, fertilisers account for around 20% of production costs on grassland farms. It is important to soil sample and prepare a fertiliser plan to ensure the correct balance of N-P-K fertilisers are applied. Changes to grassland farm P limits under the new Nitrates Action Programme (NAP), provides greater opportunities to tailor fertiliser plans, in terms of products, rates and timings, especially on low P fertility fields (Index 1 & 2). Take note that additional P allowances are available if slurry is recycled onto low P fertility soils (i.e. Index 1 or 2).

Grazing Ground N, P & K Requirements

There is a low to medium P and K demand on grazing areas of the farm as the majority of P and K is recycled back onto the pasture by grazing livestock. Nitrogen timings and rates will depend on stocking rate, soil type and grass demand during the season. The ideal fertiliser type for grazing ground typically has a P:K ratio of 1:2. Fertilisers such as N-P-K: 18-6-12 or 10-10-20 supply both P and K in the correct ratio to replace P and K offtake during grazing. Approximately 50% of the recommended P and K should be applied in spring once significant grass growth starts, i.e. second or third fertiliser round in March or April depending on soil conditions. The remaining P can be applied in May or June, during the period of peak grass growth, to ensure sufficient P in grazed grass for livestock. Maintenance rates of K should be applied during spring and early summer and fertiliser K for soil K build-up should be applied later season (August/ September).

Table 1. Recommended rates of P and K for drystock farms stocked at 2 LU/ha.

Soil P & K Index	N	P ¹	K ²	Typical N-P-K Fertiliser products ³
1	125	30	75	300kg 10-10-20 + 205kg /ha Protected Urea
2	125	20	45	200 kg/ha 10-10-20 + 225kg/ha Protected Urea
3	125	10	15	400 kg/ha 27-2.5-5
4	125	0	0	270kg/ha Protected Urea

¹ Adjust P rates for concentrate P fed on farm each year
² Additional K (75 or 35kg/ha) is required at Index 1 & 2 for build-up once every 5 years
³ Protected Urea = Fertiliser Urea N treated with the ureases inhibitor NBPT

Additional P for soil fertility improvement

Soil fertility improvement brings about many agronomic, environmental and economic benefits for the farm. Under the new NAP the rates of P allowed for build-up of index 1 and 2 soils to the optimum of index 3 have increased (see table 2). These higher P application rates will facilitate the rapid build-up of low fertility soils and increase their grass production capacity. Higher P rates are available on farms with the following criteria; a grassland stocking rate above 130 kg organic N/ha, soil test results for every 5 ha and the farmer must have a farm fertiliser plan developed in conjunction with a FAS Advisor.

Table 2. Soil P build-up rates on drystock farms stocked at 1.75 to 2.25 LU/ha.

Soil Index	P ¹ (kg/ha)	K (kg/ha)	Fertiliser products ²
1	63	90	0-16-0 / 18-6-12 / 10-10-20 / 23-10-0
2	43	60	0-16-0 / 18-6-12 / 10-10-20 / 23-10-0
3	14	30	230 kg 18-6-12
4	0	0	0

¹ Adjust P rates for concentrate P fed on farm each year
² Consult farm fertiliser plan for planned fertiliser programme (product and timings)

To maximise the return from additional P applied, it is recommended to correct soil pH to the optimum range of pH 6.3 to 6.5. This is the first step to building soil P and will increase the availability and efficiency of extra P applied. Secondly, a split-by-split fertiliser programme will be required as fertiliser compounds containing high levels of P will have to be used more frequently, for example N-P-K: 23-10-0 or 0-16-0 type products. Thirdly, to maximise the return on the cost of extra P, it is important to increase grass utilisation by increasing the number of grazing days during the year.

Fertiliser Programme

A fertiliser programme should encompass applying the right fertiliser products, in the right place (field), at the right rate, and the right time. The aim of the fertiliser programme is to match N-P-K-S nutrient requirements with grass demand over the growing season. Well drained versus poorly-drained soils may have a different grass growth profile and hence nutrient demand over the season. Differences between well- and poorly-drained soils may be more noticeable in early spring in relation to the timing and rates of the first and second rounds of fertiliser. For example, on well-drained soils cattle slurry or ½ bag/ac of protected urea may be applied in February if soil temperatures and ground conditions are favorable. However, on poorly-drained soils, it may be prudent to hold off the first round of fertiliser until soil conditions improve in late February/early March. Where no slurry is applied, an N-P-K compound (e.g 18-6-12) should be applied in the second or third fertiliser rounds (March/April) to help boost soil P availability before the onset of high grass growth rates. Contact your local advisor or consultant to prepare a fertiliser plan for your farm using the Teagasc fertiliser planning and mapping programme NMP Online.

Farmland habitats will be an increasingly important component of sustainability assessments

John Finn and Daire Ó hUallacháin
Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

- Summary
- The inclusion of farm maps of habitat features is becoming an urgent requirement for assessments of farm-scale sustainability.
 - Work is on-going to develop cost-effective methods to assess farmland habitats.

Introduction

A reputation for environmental sustainability underpins the reputation of Irish food and drink products and position Ireland as a leading source of high quality, sustainable products. To complete the profile of environmental sustainability of Irish farms requires more detail in relation to farmland biodiversity, an area where Irish farmland generally has a competitive advantage for incidence of farmland habitats.



Methodology to assess farm habitats – without farm visits

The inclusion of farm maps of habitat features is becoming an urgent requirement for farm-scale sustainability assessments and for compliance or benchmarking with international certification schemes e.g. Sustainability Assessment Initiative (SAI) platform. Traditionally, habitat surveys involve visits to individual farms, which is expensive and time-consuming. Teagasc has been working closely with Bord Bia on a pilot project to develop a cost-effective and scalable method to map farm habitats (see figure 1). This method does not require a farm visit, which reduces the costs substantially. An acceptable level of accuracy has been demonstrated using orthophotography (aerial imagery) to describe farmland wildlife habitats. This is a major advance that reduces the logistical effort associated with farm-by-farm field surveys; the pilot project still required an ecologist to interpret the aerial imagery for each individual farm. Future work is

investigating automated methods to recognise habitats from satellite imagery, which should speed up the work, make it more scalable, and reduce costs further.



Figure 1. Example of a habitat map, with habitat areas/lengths as well as selected images from the farm.

Acknowledgements

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Multi-species mixtures increase yield stability: research from Johnstown Castle

John Finn¹, Saoirse Cummins¹, Guylain Grange¹ and Caroline Brophy²

¹Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

²Department of Mathematics and Statistics, Maynooth University, Maynooth, Co Kildare

Summary

- Multi-species mixtures (two grasses, two legumes and two herbs: ryegrass and timothy, red and white clover, chicory and plantain) produced higher yields, resist weed invasion, increase total nitrogen capture and have higher resilience to drought.
- In 2018, multi-species mixtures with 150 kg of nitrogen yielded more than perennial ryegrass monocultures with 300 kg of nitrogen fertiliser.
- Multi-species mixtures can increase yield stability under drought conditions.

Introduction

Ruminant systems in oceanic regions of Europe are mostly specialized in intensively managed grasslands for feeding livestock. Plant diversity in four-species mixtures has been shown to have a strong effect on productivity of intensively managed grasslands throughout Europe (Finn *et al.*, 2013). The positive yield effects of multi-species mixtures can compensate for a substantial reduction in nitrogen fertilizer and its associated greenhouse gas emissions. In a more recent experiment, we investigated the effect of functional group (FG) diversity on yield in communities with up to three functional groups (grasses, clovers and herbs).



Multi-species mixtures: an international experiment.

We tested whether (a) multi-species mixtures can outperform monocultures both in terms of productivity and weed suppression, and: (b) whether diversity benefits will be persistent through time, and (c) whether diversity benefits will be consistent across a wide geographical scale. A common experiment was established at 31 sites across Europe and Canada, and managed by mechanical harvesting of plots. At all sites, mixtures consisted of two legumes and two grasses; with the species chosen for each location from one of four standard species-groups (Finn *et al.* 2013). Fertiliser application was between 0 and 150 kg N/ha per year.

Over a three-year experiment, this work showed that:

1. In general, mixture yields of the four-species mixtures exceeded yields of the best-performing monocultures. This points to the benefit of mixing species, due to their increased ability to access nutrient and light resources.
2. Mixture benefits were strongly related to the proportion of legumes in the sward. The provision of symbiotically-derived nitrogen from legumes (red and white clover) is an important driver of the effect of mixtures, and helps to replace the need for inorganic nitrogen supplied as fertiliser.
3. Mixtures were highly resistant to weed invasion. We did not apply post-emergent herbicides. In mixtures, the percentage of weed biomass in the mixtures were less than 4% of total yield in year three, whereas the percentage of weeds in monocultures increased from 15% in year one to 32% in year three.
4. The benefits of mixtures were observed across multiple geographical sites with very different soil, climate and biotic conditions. This indicates the reliability and general of the benefits.

Next steps: experiments with six-species mixtures

In a recent experiment at Johnstown Castle, yield of a six-species mixture (perennial ryegrass, timothy, red clover white clover, plantain and chicory) fertilised with 150 kg N/ha per year outperformed the *Lolium perenne* monoculture fertilised with 300 kg N/ha (12219 kg/ha per year and 10732 kg/ha per year respectively). This adds to the evidence base indicating multi-species mixtures as an agronomic option to reduce inorganic fertiliser use and associated greenhouse gas emissions. We also investigated nitrous oxide (a potent greenhouse gas) emissions from the mixtures during one whole year of fertiliser application. This was done using static gas chamber technology. Preliminary results show that nitrous oxide emissions were related to the fertiliser amount and to the inclusion of legumes; however, combinations of legumes and herbs resulted in considerable reductions in nitrous oxide emissions. In addition, the emissions per unit biomass of yield were reduced in herb-legume mixtures. Work at Johnstown Castle used simulated drought for about nine weeks, mixture diversity was related to an increase in yield stability. Further work is underway on this topic.

Conclusion

Multi-species mixtures generally yielded more than the best-performing monocultures. They resisted weed invasion over three years. Mixture effects (related to clover content) are sufficiently strong to allow reductions in nitrogen fertiliser without reductions in yield compared to ryegrass monocultures. Mixtures conferred higher yields under drought. Our next priority is to conduct grazing trials with multi-species mixtures; international research suggests that they should maintain their benefits under grazed conditions.

Acknowledgements

This work was supported by the Teagasc Walsh Fellowship programme, and the EU FP7 AnimalChange project.

Grass10 Beef Grassland Farmer of the Year – take home messages

John Watchorn (Farmer), Fergus Bogue, John Maher and John Douglas
Teagasc, Moorepark, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

Summary

- The farm is achieving a beef output of 1429 kg LW/ha (three times the national average) from a low-cost system (grass based).
- John turns out cattle in mid to late January and houses the last of his cattle in the first week of November, this is a huge cost saving.
- John targets an ideal pre-grazing cover of 1,400 kg DM/ha (8-10cm). John measures grass on PastureBase Ireland to ensure ideal grass ahead of livestock all year round.
- From 2015 to 2018, the percentage of the farm with the ideal pH (6.2 to 6.5) has increased from 15% to 65%.

Introduction - Farmer Profile

Name	John Watchorn
Enterprise	Beef farmer
Address	Newbawn, New Ross, Co. Wexford
Farm size	44 hectares
2017 annual tonnage	Average 13.5t grass DM/ha
Grazings	seven grazings per paddock per year
Stocking Rate	2.45 LU/ha
Output (kg/ha)	1427 kg/ha (live weight sold)

Background

I have a trading system buying in weanling bullocks and bringing them through to finish at two years of age. I mostly buy Friesians, Aberdeen Angus and Hereford off the dairy herd. I may buy other cattle if they are value in the mart. I have reared dairy calves in the past and have found it a good system; however I like going to the mart and I can buy value. This removes the work involved in calf rearing. My sheds are empty in the summer and if I see good value bulls, close to 450 kg that I can finish in the shed, I will buy them and have made money from them.



I aim to finish 150 cattle every year. In order to produce this beef profitably I must make the best use of grass. To me this means turning cattle out to grass as early as possible, grazing the fields as often as possible and housing as late as possible, keeping in mind I need grass for the spring. My motto is I need to grow more grass to feed more cattle to put more money in my pocket. Most years I let cattle out in mid to late January and house the last of my stock in the first week of November, this is a huge cost saving. I have been a member of a discussion group for a long time and I joined a grass group with Martina Harrington five years ago. Since then I have really focussed on four main areas; grazing infrastructure, soil fertility, grassland management and reseeding.

1. Grazing Infrastructure

I increased the number of paddocks from 35 to 66, each being approximately 0.6 ha, giving me one and a half day paddocks. Many of the paddocks are temporary. In order to do this I had to put in water troughs so I could easily split the fields. I zigzag the troughs so each drinker can serve more paddocks. I have one main roadway through the farm; this has been invaluable in moving stock. I have plans to add in more roadways to make the fields at the end of the farm more accessible. These do not have to be full roadways, a few stakes and wire can make a roadway in a drystock situation.

2. Soil Fertility

In 2015 I soil sampled the whole farm and I was disappointed with the results. The pH and phosphorous levels were very low. The potassium levels were okay. Not one field on the farm had optimum soil fertility. I decided to start correcting my pH first, as this would automatically help to increase the availability of phosphorous in the soil. I applied two tonnes of lime per acre over the whole farm over the following four years. I also concentrated on my phosphorous levels; I started to apply compounds with higher levels of P, and apply them earlier in the year for earlier grass. I apply slurry to silage ground as much as possible to keep the potassium levels up.

3. Grassland Management

I believe that the key to profitable beef farming lies in excellent grassland management. When I joined the grass group I was a novice, but working with the other group members who had more experience, and by meeting frequently and discussing our grass wedges, my confidence has grown. I would recommend PastureBase Ireland and a grass group to all of you. In spring, I complete a farm cover, put that into PastureBase and then do a spring rotation planner. From April on I measure grass weekly as things change rapidly from there on. I use PastureBase to look at my growth, my demand, my days ahead and my whole farm cover. In autumn, I close the fields from October 1st to November 15th in a rotation to suit how I would like to graze them in the spring.

4. Reseeding

I reseed 10-15% of the farm every year, and I have reseeded 70% of the farm in the last 10 years. I use the grass seed Top Five Extend for the most part which has Abergain, Aberchoise, Dunluce, Drumbo and Aberherald. Last year I used a monoculture of Abergain for the first time; it has worked very well so far.

Land drainage design in Ireland

Pat Tuohy¹ and Owen Fenton²

¹Teagasc, Moorepark, Animal and Grassland Research and Innovation Centre, Fermoy, Co. Cork

²Teagasc, Crops Environment and Land Use Programme, Johnstown Castle, Co. Wexford

Summary

- The first step of any drainage works is to carry out 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 optimum system and its design depend entirely on the drainage characteristics of the soil.

Introduction

The objective of any form of land drainage is to remove excess water from the soil, to lower the water table, and to reduce the period of waterlogging. This lengthens the growing season, the grazing season, the utilisation of grazed grass by livestock and the accessibility of land to machinery. A number of drainage techniques have been developed to suit different soil types and conditions. Broadly speaking, there are two main categories of land drainage:

- **Groundwater drainage system;** a network of deeply installed field drains exploiting permeable layers.
- **Shallow drainage system;** where the permeability is low at all depths a shallow system, such as mole or gravel mole drainage, improves soil permeability by cracking the soil and encourages water movement to a network of field drains.

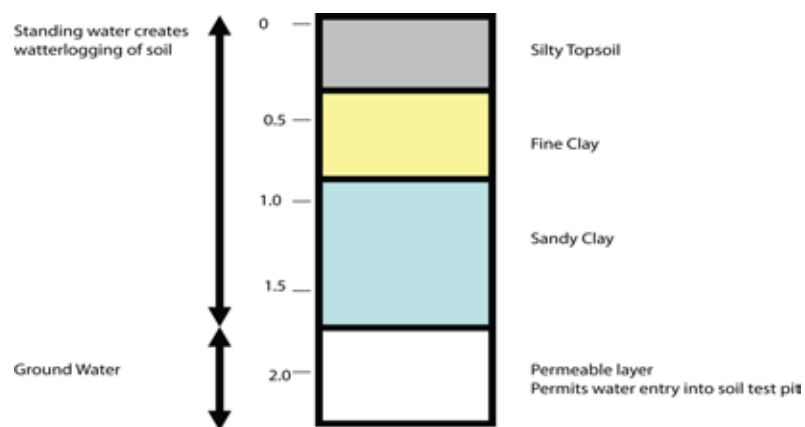


Figure 1. A typical heavy soil profile. If a free draining layer (called “permeable layer” here) is present at any depth then a groundwater drainage system is the most appropriate solution, if not then a shallow drainage system is required.

Groundwater drainage system

In soil test pits where there is strong inflow of water or seepage 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. The installation of field drains at the depth of inflow will facilitate the removal of groundwater assuming a suitable outfall is available. Conventional field 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 field drains are usually installed at a depth of 1.5 to 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. Field drains should always be installed across the slope to intercept as much groundwater as possible, with main drains (receiving water from field drains) running in the direction of maximum slope.

Shallow drainage system

Where a test pit shows no inflow 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 that 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 mole drains 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 that controls the flow of gravel. During the operation the hopper is filled using a loading shovel or a belt conveyor from an adjacent gravel cart. Gravel moles require a gravel aggregate within the 10 to 20 mm size range to function properly.

Land Drainage Publications

The Teagasc Manual on Drainage - and Soil Management is available from Teagasc offices or can be ordered via the Teagasc website, www.teagasc.ie/publications. Search “Teagasc Manuals”. A freely downloadable practical guidebook to land drainage is available via the Teagasc website, www.teagasc.ie/publications

Protected urea for maintaining yield with lower emissions

Patrick Forrestal¹, Dominika Krol¹, Mark Plunkett¹, Cathal Somers², Gary Lanigan¹ and Karl Richards¹

¹Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

²Agricultural Sustainability Support and Advisory Programme

Summary

- Nitrogen fertiliser is a key input for maximising grass growth on Irish farms.
- Protected urea can be used as a direct replacement for CAN across the growing season and produces the same yields as CAN.
- Protected urea reduces greenhouse gas and ammonia emissions

To achieve grass growth potential, fertiliser nitrogen (N) is a key input. However, fertiliser N also plays a role in gaseous N losses and water quality. In relation to gaseous emissions agriculture accounts for 33% of national GHG emission and 98% of ammonia emissions and is consequently under the spotlight to reduce emissions. The use of protected urea in place of CAN is the largest single avenue currently open to make these reductions.

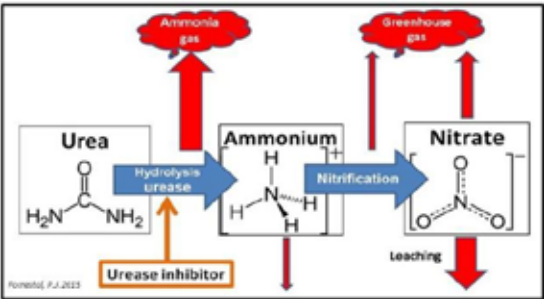
Understanding protected urea and how it works

What is protected urea?

Protected urea is urea which is treated with an active ingredient called a urease inhibitor. The urease inhibitor can be either coated onto the outside of the fertiliser granule or incorporated into the urea granule melt during manufacture.

How does a urease inhibitor work and what role does it play in stopping ammonia loss?

Urease is the enzyme which catalyses the conversion of urea to ammonium. It is during this conversion that ammonia gas is lost from untreated urea. A urease inhibitor blocks the active site of the urease enzyme. This moderates the rate at which urea converts to ammonium. By doing this, ammonia loss is reduced to low levels.



Is there different urease inhibitors used in protected urea?

Yes, NBPT, 2-NPT and NBPT+NPPT are effective urease inhibitors.

Can I spread protected urea throughout the growing season?

Yes, you can spread at times when you would otherwise spread CAN or unprotected urea.

Will using protected urea reduce yields and N efficiency?

No, published Teagasc trials (Figure 2) have shown that protected urea consistently yields as well as CAN and is as efficient in Irish grasslands.

Does protected urea reduce loss of the potent greenhouse gas nitrous oxide?

Yes, published Teagasc trials have shown that protected urea has 71% lower nitrous oxide emissions than CAN (Figure 2).

Does protected urea reduce loss of Ammonia?

Yes, based on published Teagasc research protected urea has comparable ammonia loss to CAN and ammonia loss is reduced by 79% compared to urea (Figure 2).

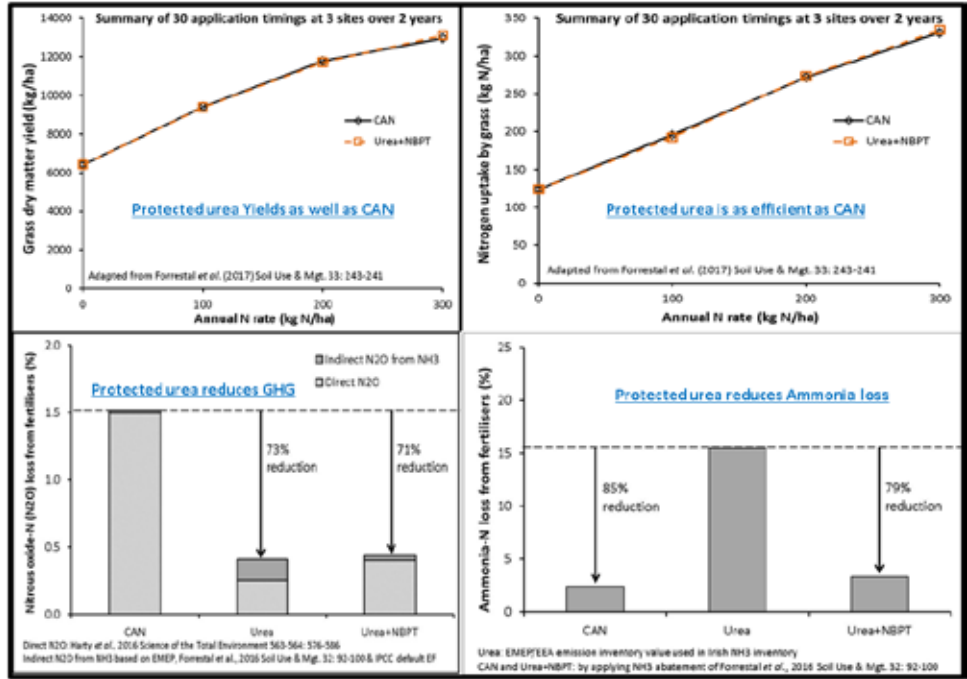


Figure 2. Effect of protected urea on yield, N recovery, GHG nitrous oxide and ammonia.

Is protected urea more costly?

No, see prices (Table 1) as per 14th March 2019.

Table 1. Prices, €/t fertiliser and €/kg N delivered, for the three main fertiliser N types.

Fertiliser N product	N content (%)	Cost per tonne (€)	Cost/kg N (€)
Urea	46%	391	0.85
Protected urea	46%	437	0.95
CAN	27%	284	1.05

Conclusion

Use of protected urea can reduce agricultural greenhouse gas emissions and ammonia emissions while maintaining yield and saving cost to the farmer.

Assessing and monitoring soil quality in Irish grassland soils

Giulia Bondi, Fiona Brennan and David Wall
Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

Summary

- Soil quality is essential for sustainable land management and grass production.
- The effects of machinery trafficking operations and grazing livestock intensity on soil compaction and quality were assessed across grassland soils in Ireland
- High machinery trafficking pressure has a greater influence than grazing livestock pressure on soil structural quality and the delivery of almost all soil functions.
- The effects of trafficking and livestock intensity on soil structural quality were different depending on soil drainage characteristics, with wetter soils easier damaged.

Introduction

Irish agriculture is dominated by grass-based animal agriculture which enables farmers to produce milk and meat products in a sustainable manner while competing on world markets. Agriculture today is faced with the need to increase primary productivity in order to meet the global demand for food security. At the same time society expects that the intensification of primary productivity is matched with an equal emphasis on the sustainable usage of natural resources. In Ireland, the Food Wise 2025 objectives to intensify agriculture are coupled with greening objectives of the Common Agricultural Policy amongst other environmental policy. Thus, any intensification of agriculture must be achieved in a sustainable manner.

Soil functions

- The soil provides a range of ecosystem services, which are defined as five main functions;
1. Production of food, fibre and fuel,
 2. Carbon cycling and storage,
 3. Water purification and regulation,
 4. Nutrient cycling, providing plants with the essential elements that they need to grow,
 5. Soils provide a habitat for biodiversity, with the largest store of life on earth.

All soils have the capability to perform multiple functions simultaneously but the capacity at which each function is performed will vary across soil types, land use and climatic region. Grasslands are considered balanced systems in supplying functions, however certain land use operations typically carried out in grassland systems are known as having an impact on soil quality and functionality. In particular, animal grazing and machinery traffic may lead to serious damage to vegetation and soil.

Many studies have demonstrated that these operations contribute to the breakdown of soil aggregates, making the soil more subject to decreased porosity and compaction. This damages the soil structure, which is a key factor that supports all soil functions. Because of this, there is a need to assess the effect of different management practices on soil quality, and to combine it with the soil’s ability to respond to management changes. This combination of management activities and soil functional quality was evaluated in Ireland.

Material and methods

A survey of grassland soils was undertaken. This survey was representative of the main soils and five major agro-climatic regions of Ireland. Detailed analysis of soils and herbage were taken from 38 grassland farms where a series of samples and measurements were conducted using soil profile pits and both *in situ* and laboratory analysis. The different soil functions were assessed through the measurement of commonly used parameters of soil quality. In order to assess the impact of management operations on those functions, and aiming to study synergies and trades off between them, the farms were classified into intensive and extensive on the basis of management information collected through on-farm questionnaires. The questionnaire aimed to capture the common farming practices carried out in Irish grassland soils based on; (i) Intensity of Trafficking operations and (ii) Intensity of Livestock Grazing.

Results

The table below summarises the influence of highly intensive management practices on each soil function. The symbol (+) indicates greater influence on different soil physical, chemical, and biological parameters related to the five soil functions. Soil structure has been added due to its importance as a key driver of soil functionality.

Table 1. The effect of high trafficking and grazing pressure on soil functions and structure

	High Trafficking Pressure	High Grazing Pressure
Primary Productivity	+	
Water purification and regulation		
Carbon sequestration	++	
Biodiversity	+	+
Nutrient cycling	+	+
Structure	+++	

Initial findings indicate that high trafficking pressure had a greater influence than intensity of livestock grazing on the delivery of almost all soil functions. This research identified potential weaknesses where certain soils and soil characteristics interact with certain grassland management systems and intensities. Assessments of soil physical, chemical and biological indicators of soil quality across managed grasslands identified differences in the delivery of functions according to specific soil drainage characteristics.

It was found that well drained soils were more resilient in terms of soil compaction and had high capacity to support grass production once nutrients were supplied; however, these soils presented high risk in terms of water purification and climate regulation. In contrast poorly drained soils were more prone to structural compaction and less resilient for production, showing a greater sensitivity mainly to trafficking operations. However, these soils had high capacity to sequester carbon, provide an active micro-biome and to purify water under low to moderate management intensity.

Water quality and sustainability

Edward Burgess, Per-Erik Mellander and Tom O'Connell

The Agricultural Catchments Programme, Teagasc, Johnstown Castle, Co. Wexford

Summary

- 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 capitalize on our clean environment and increase the value of our products. Protecting and improving water quality is at the core of this challenge.

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 2015-2017 shows that 44% of rivers, 51% of lakes, 69% of estuaries and 14% coastal waters (by area) assessed were classified at less than good ecological status. 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, wastewater discharges from towns and villages, and septic tanks in rural areas (see Table 1).

Table 1. Summary of Water Framework Directive water status during 2015-2017

Water Body Type	High	Good	Moderate	Poor	Bad
Rivers (% water bodies)	15	41	26	18	0.1
Lakes (% water bodies)	17	32	31	15	5
Transitional (% area)	8	16	63	12	1
Coastal (% area)	41	44	12	2.5	0.0

Source: EPA, 2017

Overall trends in river water quality since 2015 show a 3% reduction in status. This is a change from previous trends which have been either stable or improving. However, the number of high quality river water bodies has declined ten-fold since the late 80's. Encouragingly, the number of seriously polluted rivers has fallen significantly.

Transitional waters (the tidal part of our estuaries) are another water body type of concern, as a high percentage are not reaching High or Good status. Nitrate levels are considered a significant factor influencing the ecology in this type of water, and the source of this nutrient may be many miles away from the estuary.

Protecting water quality on beef farms

There are two strong incentives to encourage farmers to work towards better water quality; market demand for sustainably produced food and regulations. However, a third and probably more important incentive is 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, which is a win/win for the farmer. The most important of these are listed below:

1. Improved nutrient management planning — 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. Teagasc's Nutrient Management Planning (NMP) Online package aims to address this need by making it easier for advisers and advisors to plan and implement good nutrient management.
2. Better slurry spreading decisions — 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. The use of low emission slurry spreading methods allows slurry to be spread on grass covers not suited to splash plate applications. This enables spreading well before the start of the closed period.
3. Eliminating point sources — potential nutrient sources can be divided into point sources, such as farmyard sources (e.g. slurry tanks), and diffuse sources, such as fertilisers applied in the fields. Point sources can be divided into agricultural sources (what escapes from farmyards, milking parlors, silage pits, effluent tanks etc.) and non-agricultural sources (septic tanks etc.). The impact of point sources can be significant and their elimination will reduce pressure on the receiving waters thus leaving more 'head room' for nutrient losses from farming. The Agricultural Catchments Programme has found that point sources can have a large impact on stream water quality during the summer. Phosphorus concentrations in some streams increase as the water levels fall during the summer. This is usually a point source influence since diffuse losses from dry land in the summer don't generally happen. The ecology in streams doesn't fully recover from the damage suffered during the summer and the cycle is repeated from year to year.
4. Reducing sediment losses — Stream bank and bed erosion and road losses make up most of the sediment losses in grassland catchments. This sediment can cause significant damage to the stream ecology either directly by clogging up gravel in the stream bed or indirectly by carrying phosphorus. Farmers can reduce the sediment risk by some simple measures like taking care to avoid positioning field gaps, troughs and feeders near streams; directing runoff 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 live weight to sell. Thus, better farm management practices, while not directly targeting environmental gains, will likely have positive environmental and economic effects — a classic

Mitigating Agricultural Greenhouse Gas Emissions by improved pH management of soils (MAGGE-pH)

Ognjen Zurovec¹, Fiona Brennan^{1, 2}, Dominika Krol¹, Meritxell Grau^{1, 2}, David Wall¹ and Karl Richards¹

¹Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford

²National University of Ireland, Galway (NUIG)

Summary

- Teagasc, in collaboration with NUIG and 8 other partners from Europe and New Zealand is currently researching the effect of lime management on greenhouse emissions (mainly nitrous oxide – N₂O), soil fertility and grass productivity.
- Early results suggest that improvement of soil fertility and specifically soil pH with liming is a low-cost management change which has the potential to increase soil productivity and reduce greenhouse gas emissions.

Introduction

Nitrous oxide (N₂O) is a potent greenhouse gas with a 100-year global warming potential 298 times greater than carbon dioxide. Agriculture contributes almost 90% of total N₂O emissions in Ireland, mainly due to nitrogen (N) fertiliser use and emissions from animal manures. N₂O is therefore a primary target for greenhouse gas reduction in agriculture. MAGGE-pH concentrates on the microbial processes responsible for production and consumption of N₂O in soils, mainly the process called denitrification, which is the main source of N₂O emissions. The project focuses on improving our understanding of how soil pH controls these processes. The evidence for the pH effect on N₂O emissions stems almost exclusively from laboratory experiments (Figure 1). Now we need stringent testing of different liming strategies under realistic field conditions. This will be the core activity in MAGGE-pH, where Teagasc, in collaboration with NUIG and 8 other partners from Europe and New Zealand will investigate the effects of soil pH on N₂O emissions from a range of N fertilizers/manure/urine/biochar. We will also explore the use of non-calcareous rock powders as a replacement for traditional liming materials (carbonates).

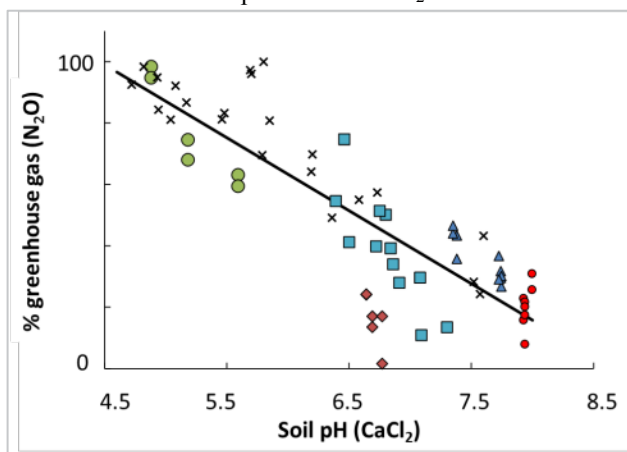


Figure 1. The results from laboratory experiments on Scandinavian and Chinese fertilizer experiments suggest the % N₂O can be substantially reduced by increasing soil pH.

Teagasc liming trial at Johnstown Castle

The liming and phosphorus trial at Johnstown Castle was established in 2011. Plots of 1.5 m wide by 6 m long were marked out at each site and sown with perennial ryegrass. There are 24 separate treatments which were randomised within each of four replicated blocks, resulting in a total of 96 plots. For the purposes of MAGGE-pH, we selected four different lime treatments and two phosphorus treatments (32 plots in total), and installed chambers for greenhouse gas measurements (Figure 2).

By applying different lime rate treatments on the site, over the last 8 years, we have a wide range of soils with differing pH across treatment plots, ranging from 5.4 (the control treatment, which never received lime) up to 7.1 in our highest pH treatment (limed three times since 2011). All plots (treatments) will receive 300 kg of N fertiliser split in 7-8 applications after each harvest in order to mimic a typical grazing fertilizer application regime over the growing season. In addition to greenhouse gas measurements, soil and herbage samples are taken regularly from the same plots in order to measure all important soil and grass yield parameters across the growing season. Greenhouse gas measurements commenced in February 2019 and are expected to be monitored for 12 months. Soil samples from the same plots are also used in laboratory experiments, where the mechanisms of microbial N₂O production are analysed in more detail using modern and novel analytical methods.



Figure 2. Measurement of greenhouse gas emissions with the installed chambers

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Four key factors for a sustainable production system

- ✓ Select optimum system for your farm
- ✓ Purchase stock from high terminal index sires
- ✓ Optimise calf health and welfare
- ✓ Maximise grass utilisation

Would you adopt the following technologies on YOUR farm?

- Enhance soil fertility and lime status
- Use of clover in swards
- Low Emission Slurry Spreading
- Use protected urea

