Profitable beef production from the dairy herd

Dairy calf-to-beef Conference
Teagasc, Johnstown Castle Research Centre

9th November, 2010

Teagasc
Agriculture and Food Development Authority

Dawn Meats

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Summary

- The number of male dairy calves produced on Irish dairy farms is increasing rapidly from 260,000 in 2007 to 320,000 in 2010 and is likely to grow to over 400,000 by 2020 as the dairy herd expands.
- Dairy farmers are likely to become more specialised as quotas are phased out leading to a higher proportion of male calves coming on to the market at a very young age.
- The supply of male dairy calves is highly seasonal with almost 80 per cent born in the first four months of the year and this seasonality is likely to continue with a slightly earlier mean calving date.
- Almost half of all male dairy calves are exported live at a few weeks of age at relatively low value to the agricultural sector or the economy as whole
- The objectives of this programme are to develop a range of calf-to-beef systems which produce sustainable returns for the producers and a marketable product for the processor.
- The development of specialised calf rearing skills on beef farms is central to the realisation of a prosperous calf-to-beef industry.

Introduction

From the introduction of quotas in 1984 until 2007, approximately 55 per cent of all dairy cows were bred to beef bulls with the remainder bred to dairy sires to generate replacements for the dairy herd. Currently, approximately 60 per cent of dairy cows are bred to dairy bulls with the remainder to beef bulls of Angus (14%) Hereford (11%), Limousin (6%) and other continental (5%) breeds. The increased use of dairy sires on dairy herds will lead to an increase in the national dairy cow population of 3-4 per cent / annum from 2011 and in addition to realising a national dairy herd size of over 1.35 million dairy cows by 2020 (Table 1), will also result in a substantial increase in the number of male calves from the dairy herd.

While milk quotas were in place, dairy farmers reared bull calves as a means of increasing gross output of the dairy herd, however, it is anticipated that post quotas, dairy production will become more specialised and fewer dairy farmers will rear calves for beef production leading to a very significant increase in the number of male dairy bred calves coming on the livestock market.

Table 1. Male dairy calf and dairy cow numbers from 2006 to 2010 and projected to 2020 based on current replacement rates

Year	*Male Dairy Calves*	*Dairy Cows*
2006	254,209	1,038,520
2007	264,911	1,038,531
2008	279,096	1,032,432
2009	319,249	1,016,875
2010	315,311	1,017,131
Projected		
2011	326,946	1,054,664
2012	334,479	1,078,964
2013	343,445	1,107,888
2014	352,297	1,136,442
2015	361,476	1,166,053
2016	370,867	1,196,346
2017	380,510	1,227,451
2018	390,401	1,259,357
2019	400,549	1,292,095
2020	410,962	1,325,684

Live Exports

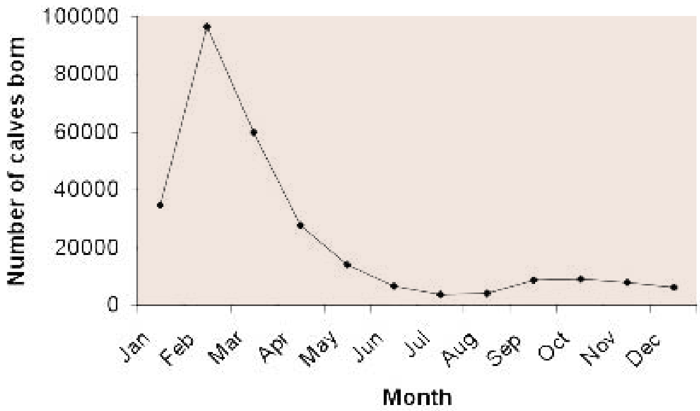
Over the last few years there has been a very significant increase in the number of male dairy calves going for live export for veal production in continental Europe with over 160,000 likely to go in 2010, or over half of the total number of males born. These calves are currently leaving the country at relatively low value to the agricultural sector or the economy as a whole. The 'Food Harvest 2020' document sets a target of increasing the value of beef exports by 20 per cent or approximately €300 million over the next ten years. If the calves that are currently exported live were reared to beef in a bull beef system, it would add an estimated €120 million to the value of agricultural exports. The realisation of this scenario requires that all participants, including farmers who rear dairy calves to beef, can realise sustainable returns to justify their effort and investment in rearing.

The objectives of this new joint programme between Teagasc and Dawn Meats are to integrate the calf to beef production system with product marketing and, therefore, develop systems of production that are efficient and profitable for the producer and produce a product that is marketable by the processor.

Seasonality

Milk production in Ireland is highly seasonal to maximise the economic efficiency of grass based production and consequently, over 80 per cent of the dairy cows are calved at the start of the grass growing season (Figure 1) with a peak in February and most of the calving completed by mid-April. In a non-quota environment, the optimum calving date for a grass based production systems is approximately two weeks earlier than in a quota regime. Since the introduction of the Economic Breeding Index (EBI), dairy farmers have begun to breed for cows with superior fertility and this allow much better control over the mean calving date of the herd in future. Additionally, as the dairy industry expands, increased pressure on processing capacity will result in seasonality bonuses to motivate farmers to move to earlier calving. It is therefore, anticipated that there will be a national move to earlier calving with an increased proportion of calvings in January and February and less in April and May resulting in increased seasonality of male dairy calf supply. As the market requires a relatively uniform supply of fresh beef, it is likely that a range of systems of production must be developed which may be suited to different farmers depending on farm circumstances and resources.

Figure 1. Seasonality profile of male dairy calf births



Calf Rearing

On most dairy farms, because of the seasonality of production, there is a significant demand for labour in spring as the work loads of calving cows, milking start-up and calf rearing coincides. For this reason, many dairy farmers, particularly those with bigger herds, try to sell the non dairy replacements as young as possible to reduce the workload and to concentrate their efforts and resources on the dairy heifer calves. This trend towards more young male dairy calves being sold is likely to continue as dairy farmers expand milk production post-quotas. As there are very few farmers willing to buy these calves and invest the time and resources required to successfully rear them, the majority are exported live to continental Europe for veal production.

The skills required to successfully rear milk fed calves on Irish beef farmers is likely to be a limiting factor to the development of viable industry using beef calves from the dairy herd. In many other countries, such as Australia, New Zealand, the UK and the US, where significant dairy beef industries exit, this role is filled by specialised calf rearers. The development of specialised calf rearing enterprises has potential on many Irish dry stock farms that have adequate labour and usable facilities and a requirement for a more reliable income sources into the future.

Beef Market Prospects

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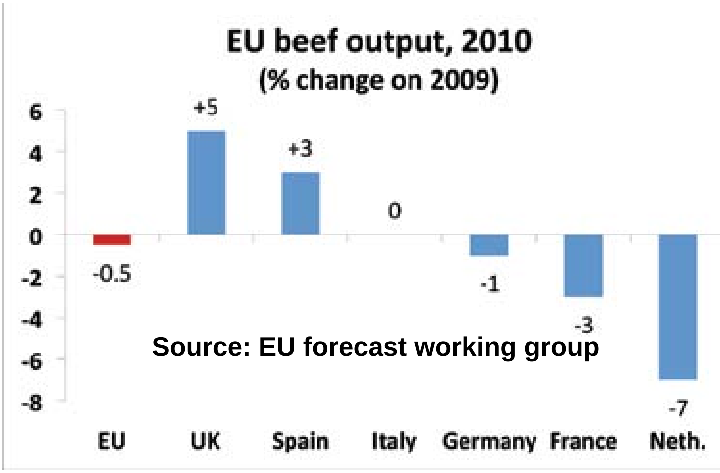
Following difficult trading conditions due to weak market demand, particularly for higher value cuts, the European beef market has shown signs of stabilising over recent months as a combination of tighter availability and a more positive currency situation has helped the trade. The prospects over the coming months point to the relatively tight supply situation continuing across a number of key European markets while Irish finished cattle supplies are also set to tighten.

More stable European market

Recent months have seen some indications that consumer demand for beef across Europe is starting to level off and in some cases improve, with a better trade reported for steak cuts. Latest household purchase data from the UK shows that for the quarter ending the 3rd October, the volume of beef purchased by UK households rose by two per cent to 64,000 tonnes. Figures for France show some slight recovery in beef consumption as the year progressed, following a very slow start to 2010 sales. Consumer decisions will be closely related to economic developments and with most of our main European markets forecasting some recovery in the second half of 2010, there is reason to expect some improvement in beef consumption.

Lower EU cattle supplies

In terms of beef supplies, some decline in EU beef production is anticipated. Some key beef producers, including France and the Netherlands are expecting lower output in 2010, with most of this occurring during the second half of the year. However, this will be partly offset by increased production in Poland, the UK and Spain.



UK beef production in 2010 is forecast to rise by around 5 per cent. Firm market prices have led to more dairy calves being utilised for young bull beef production with supplies in the January to October period 34 per cent higher than a year earlier. In addition, stronger imports of finished cattle from Ireland, higher than anticipated cow supplies and rising carcase weights have combined to boost UK production.

Looking ahead to 2011, little change is anticipated in UK prime cattle supplies, although, the rise in production from the dairy herd looks set to be maintained.

EU Imports recovering slowly

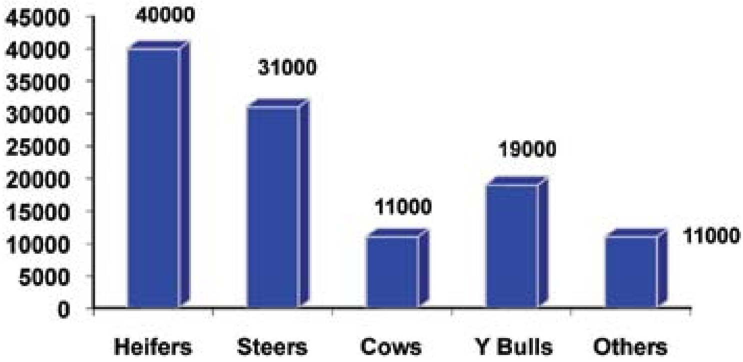
In terms of EU beef imports, some recovery is expected for imports during 2010 with shipments forecast to increase by around five per cent to 440,000 tonnes. However, this would leave imports more than 15 per cent below the levels recorded as recently as 2007.

South American countries will remain the principal suppliers to the EU market, although, there is likely to be some shift in the volumes shipped by the main suppliers. Between Brazil and Argentina volumes of beef imported were down 15 per cent to 98,500 tonnes for the first half of 2010. Brazilian imports increased by just 2 per cent, while shipments from Argentina fell by 37 per cent over the period, reflecting the decline in beef output there. For the year, a fall of more than 40 per cent in Argentinean beef exports to 400,000 tonnes has been projected given the liquidation of the beef herd and Government restrictions on exports. Stronger imports, albeit from a small base, were also recorded from North America in the form of higher value cuts. Given the anticipated supply/demand developments for 2010, the European beef market appears to be heading into a more stable period, which should help the market environment for Irish beef.

Irish cattle supplies to tighten

To-date, finished cattle supplies at export meat plants have been strong as a combination of a higher carryover from 2009 and limited live exports of calves and weanlings in 2008 have boosted availability. Up to the week ending, the 16th October total export meat plant supplies were 112,000 head or nine per cent above the corresponding period a year earlier.

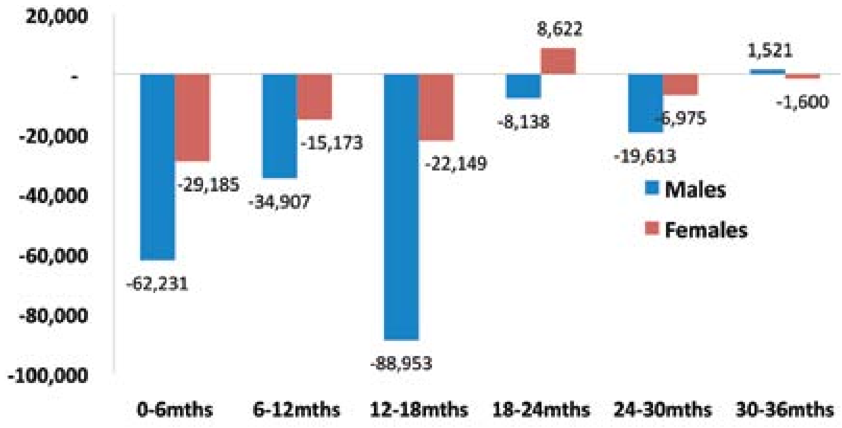
Increases have been evident across all animal categories with the growth in young bull disposals continuing with supplies almost 19 per cent higher up to mid October. The largest percentage growth has been evident in bulls and heifers.



Export Meat Plant Cattle Supplies, January to 16th October (Change in head)

Source: Bord Bia based on DAFF

Figures from the Department of Agriculture, Fisheries and Food's AIM database for the 1st August 2010, confirm the decline in younger cattle numbers due to lower calf registration and higher live exports over recent years. The figures show a drop of 279,000 in the number of cattle less than 36 months, with 253,000 of this drop evident in animals less than 18 months of age.



Trends in cattle numbers by age, August 1st 2010 (Change in head on August 2009)

The figures for 18 - 36 month old animals showed a fall of 26,000 in male cattle while females were unchanged on 1st August last year.

However, strengthening male cattle disposals since the 1st August have been offset by lower supplies of female cattle. During this period, an increase of 13,000 in male cattle numbers was evident with 7,000 fewer females marketed. This would point to a tightening in steer and heifer supplies as the onset of the winter season approaches. However, this is likely to be partly offset by young bull supplies remaining ahead of last year. The main uncertainty regarding disposals over the coming months surrounds the likely producer reaction to higher feed costs. Any effort by producers to reduce their reliance on animal feed over the winter months could impact on marketing patterns over the coming weeks.

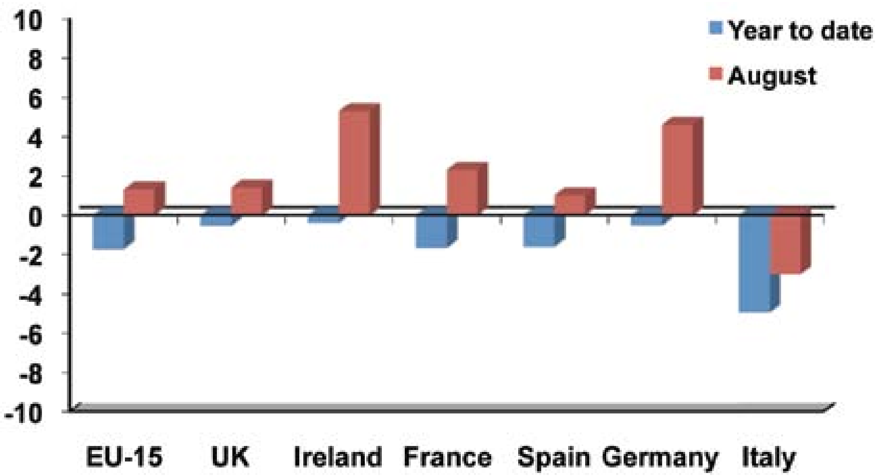
The strength of live exports since late 2008 combined with lower calf registrations seems set to lead to a significant tightening in finished cattle supplies in 2011 as demonstrated by the drop of almost 90,000 head in the number of male cattle aged between 12 and 18 months on the 1st August 2010 with female numbers in the category down by 22,000 head.

EU cattle prices

Cattle prices across Europe has been sluggish for much of 2010 as consumer spending on beef remains below traditional levels as consumers look for increased value. On a year-to-date basis the weighted EU-15 R3 male cattle price is running two per cent lower than last year at €3.13/kg. Recent months have seen some pick up with the EU-15 price in the first half of October one per cent higher at €3.14/kg compared to the corresponding period last year.

Male cattle prices among most leading producers have fallen by around one per cent on a year to date basis with Italian prices some five per cent lower and UK prices down by one per cent in euro terms. Prices for October showed mixed trends with prices in the UK, Spain, France, Germany and Sweden ahead of October 2009 levels. However, Italian prices are running around three per cent lower.

Irish R3 steer prices to date are virtually unchanged on last year's levels at €2.90/kg while prices in the first half of October were five per cent higher at €2.85/kg.



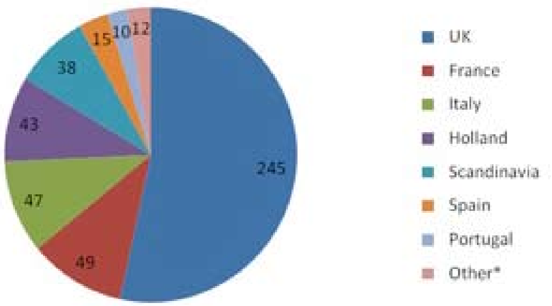
European R3 male cattle price trends, per cent change 2010/2009

Source: *EU Commission*

Markets for Irish beef

For 2010, beef exports are anticipated to increase by over 5 per cent to almost 490,000 tonnes, reflecting increased beef availability during the first half of the year. The UK market will continue to account for half of Ireland's beef exports, although the emphasis on other European markets continues to grow.

Destination of Irish beef exports, '000 tonnes for 2009



**Other includes smaller European markets and International markets*

The UK remains in a deficit beef position, with the latest EU beef forecasting meeting indicating the UK will import 406,000 tonnes during 2010. The current market position of Irish beef in the UK leaves the industry well placed to fill any increased requirements, particularly as the weakening of the euro against sterling has helped improve the competitiveness of Irish beef in the market.

Continental European markets continue to grow their share of Irish exports with 47 per cent of exports destined for this region in 2009. Key markets include France, Italy, the Netherlands and Scandinavia, which between them account for more than 80 per cent of exports to the region. Overall volumes to the Continent in 2010 are expected to rise in 2010, reflecting stronger availability to-date. Further growth in the share of exports destined for the region is expected in 2011.

Across Europe Irish beef is stocked in three or more of the top 10 retailers in each major market and in over 70 retailers in total. By the end of 2009 some 200,000 tonnes were destined for the higher value standard and premium retail and premium foodservice markets, with a further 75,000 tonnes of quality assured beef destined for the high quality high volume quick service restaurant sector.

Young bull beef from the dairy herd

The ongoing rise in young bull supplies in Ireland reflects their relatively high feed efficiency compared to steers and the potential this offers producers to improve returns. However, it also represents a system of production that requires a strong focus on producing a finished animal that is suitable for the marketplace. Most customers have age, weight and fat cover requirements and if these are not met it can lead to significant price discounts.

In relation to markets for bulls from the dairy herd, the options open to producers range from rose veal for animals less than 12 months of age to young bull beef production. For bulls over 12 months of age, there is a potential market for young bull beef from the dairy herd. However, animals need to be finished within a relatively tight specification. Typically, this will range from animals being finished at 12-16 months of age, producing a carcase of 240-340kg and ideally grading O= or better on conformation. In terms of fat score the general requirements range from 2+ to 4-.

Bull Beef Production from Holstein/Friesian Male Calves

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Summary

- The most profitable system of bull beef production is one where early born calves have a long grazing season, are well developed at the start of finishing and so require only a relatively short finishing period.
- Holstein/Friesian young bulls of 305 kg starting weight fed moderate quality silage *ad libitum* plus 3 or 6 kg concentrates per head daily or concentrates *ad libitum* gained 0.91, 1.16 and 1.40 kg/day, respectively, over a six months finishing period. Beyond 6 months liveweight gains were reduced, particularly at the higher feeding levels.
- Kill-out, carcass conformation and carcass fat score all increased with increasing length of finishing period.
- For Holstein/Friesian bulls to be adequately finished they must exceed 1 kg/day liveweight gain during finishing, be 550 kg slaughter weight and 300 kg carcass weights. Such animals kill-out at about 545 g/kg, their carcasses have a mean fat score somewhat in excess of three and are fifty per cent "R" and 50 per cent "O" conformation.
- When fed silage plus 6 kg concentrates/day mean daily gain is about 1.15 kg and the finishing period required to take animals from 300 to 550 kg liveweight is about 230 days.
- When fed 6 kg concentrates/day, silage intake is about 3.8 kg DM/day. Thus, the total feed required to take animals from 300 to 550 kg liveweight is 1.3 t concentrates plus 4.2 t silage.
- When fed concentrates *ad libitum* plus minimal roughage, mean daily gain is about 1.4 kg/day and the finishing period required to grow bulls from 300 to 550 kg liveweight is about 180 days. Concentrate intake is close to 10 kg/day and the total feed required is about 1.8 t concentrates plus 0.9 t silage.
- Above 550 kg liveweight, daily gain starts to decline and with intake continuing to increase, the decline in efficiency is considerable.
- Within the concentrate range 3 kg/day to *ad libitum*, the response to each additional 1 kg/day of concentrate was 75 g liveweight and 50 g carcass weight.
- Holstein-Friesian bulls can be fed *ad-libitum* concentrate and slaughtered at 12-13 months of age giving a final liveweight of approximately 450 kg, resulting in a carcass of approximately 235 kg, grading mainly O's with a fat score of 3.

- Average daily gains of 1.2 to 1.25 can be expected over a 250 to 280 day finishing period. In that period, 1.2 - 1.3t of concentrate DM will be consumed.

Introduction

With the forecasted expansion of Irish dairy cow number[3], following the proposed changes of the milk quota regime, there will be greater number of dairy type claves available for beef production. Initially, at least, these extra male calves will be predominantly Holstein/Friesian (and some other dairy crossbreds). Finding the most suitable beef production systems for these male dairy calves is a challenge for the industry resulting in a renewed interest in bull beef production as an option for these calves. Before decoupling of support premia, bull beef production was generally less profitable than well managed steer beef, partly because of the higher premium earning capacity of the steers. However, rearing males as bulls has inherent efficiencies due mainly to their higher production potential arising from the natural presence of the male hormone testosterone. There are many systems of bull beef production, e.g. red veal, cereal beef, conventional rearing followed by silage/ concentrate finishing and conventional rearing followed by high concentrate finishing. The economics of production is, to a large extent dependent upon calf purchase price and concentrate costs. Irrespective of production system, it is imperative that a market outlet, and the approximate sale price, be established from the outset. Clarity is also needed on acceptable carcass weight and fat cover. Once bulls are ready for sale any delay or price discounting relative to steers can greatly reduce margins.

The breed mix used on the dairy herd is summarised in another paper at this conference (Beef production from the Dairy Herd). Currently, approximately sixty per cent of the 1.0 million dairy cows are mated to Holstein-Friesian sires (to produce replacement heifers). These matings result in the production of approximately 300,000 Holstein-Friesian male calves. The earliest born (late January to late February) are well suited to many systems of bull beef production because they will be well grown before turnout to pasture and can have a long first grazing season. Thus, they will be well developed, in both size and weight, in the autumn and can proceed directly to finishing. These early born bulls should then perform well during the high growth rate finishing phase, expressing some compensatory growth. Animals which are not well developed at the start of finishing, either because of later birth date or poorer performance at pasture, will require a longer and more costly finishing period. Animals that are not put to pasture but produced in a cereal beef system for slaughter at 11-13 months of age will reach slaughter in spring time when finished cattle are generally scarce and prices high.

Holstein-Friesian Bull Production Options

As indicated already, there are a range of production options using the early born Holstein-Friesian bulls. These can range from slaughtering at under 8-months of age (veal production), to 12 month cereal beef (barley beef), to 15, 18, 21 or 24 month slaughtering. Bull age can be a discriminating factor depending on the export market. High priced European markets tend towards bulls which are under 16 months. This paper summarises Holstein-Friesian dairy bull production systems at 12, 15 and 18 months of age. A steer beef production system, at 24 months of age, is also summarised.

Rearing and Feeding Friesian/Holstein Animals

12-13 month bull beef

The suitability of late winter-born Holstein/Friesian calves for bull production was examined in a series of experiments at Grange. Mean birth dates for calves used in these studies were typically mid-March. Currently, dairy herds are calving closer to mid-February (for Holstein/Friesian calves). The calves used in the studies reported here were purchased at livestock marts at about 7-14 days of age were reared indoors on a standard calf rearing regime and were approximately 12 weeks old when they moved to a high concentrate diet before starting the studies. Animals were housed on slatted floor sheds at a density of 2.5 m2/animal throughout.

Experiment 1 investigated the effect of feeding concentrate diets with differing energy densities on the performance of young bulls (Table 1). Starting at an initial weight of 110 kg, liveweight gains were approximately 1.1 to 1.2 kg/day over the 277 day feeding period. Over the first 140 days, gains were 1.2 to 1.3 kg/day and reduced 1.0 to 1.1 kg/day during the latter half of the feeding period. Concentrate consumption was 1500 to 1600 kg DM over the 277 days. Final liveweights were in the range 430- 450 kg, giving carcass weights of 230-235 kg. Overall conversion efficiency was approximately 9:1 (9 kg of concentrate DM/kg of carcass). Carcasses graded mainly O’s and had fat scores of 3 (1 to 5 scale). A barley (85%), soyabean (13%), plus mineral (2%) mix proved to be an acceptable diet for this production system.

Table 1. Effect of ration type on animal performance

	Treatment				
	Barley/ Soya	Low-Energy	High-Energy	Low then High	Sign
Initial weight (kg)	110	110	110	109	NS
Concentrate intake (kg DM)					
1 - 140 d	747	717	744	734	
141 - 277 d	878	813	878	864	
1 - 277 d	1625	1530	1622	1598	
Liveweight gain (g/day)					
1 - 140 d	1280	1260	1340	1330	NS
141 - 277 d	1140	1010	1140	1120	NS
1 - 277 d	1200	1140	1240	1220	NS
FCR (kg conc.DM/kg gain)					
1 - 140 d	4.17	4.06	3.97	3.94	
141 - 277 d	5.62	5.88	5.62	5.30	
1 - 277 d	4.89	4.85	4.72	4.53	
Final weight (kg)	445	424	452	447	
Carcass weight (kg)	237	222	241	235	NS
FCR carcass[1]	9.1	9.3	8.9	9.1	NS
(kg conc. DM/kg carcass gain)	6.4	4.5	6.1	6.4	NS
Kidney and channel fat (kg)	2.1	2.1	2.2	2.0	NS
Conformation[2]	3.3	2.6	2.9	3.0	NS
Fat score[3]					

[1]Calculated by assuming an initial killing-out rate of 480 g/kg
[2]Based on E = 5; U = 4; R = 3; O = 2
[3]Based on fat score 1 (leanest) to 5 (fattest)

Source: Fallon, and Drennan, 1998

Experiment 2 investigated the effect of a 112 day period at pasture on the performance of spring-born Holstein/Friesian bull calves having access to either *ad libitum* or restricted concentrate feed. Starting at 125 kg liveweight, one group stayed indoors throughout on *ad libitum* concentrates, while another had access to *ad libitum* concentrates (same mix as Experiment 1) at pasture. A third group had access to grass only for the first 84 days, was then adapted to *ad libitum* concentrates over a 28 day period while still at grass and then moved indoors for the final 137 days. The full feeding period was 250 days (Table 2). Concentrate intake over the 250 day study was approximately 1600 kg DM for the both indoors, and outdoor *ad libitum* concentrate fed group. When given grass only for the first 84 days, total concentrate input (for the 250 days) was approximately 1150 kg DM. Having access to grass with *ad libitum* concentrates saved only 48 kg concentrates (during the first 112 days), while having no initial access to meal when at grass saves 447 kg concentrates. When subsequently moved indoors all groups had similar concentrate intakes over the final 137 days. However, performance was affected during the initial 112 days. Calves indoors full-time and those at grass with *ad libitum* access to concentrates had similar liveweight gains of 1.4 kg/day, while a gain of 0.8 kg/day was achieved on grass only. When moved indoors for the final 137 days, calves from the grass only treatment grew at 1.4 kg/day, compared with 1.2 kg/day for the groups on *ad libitum* throughout. Over the full 250 days, daily gains of 1.3, 1.3 and 1.2 kg/day were measured on the indoor fulltime, grass plus *ad libitum* concentrates and grass only groups, respectively. Final liveweights were 442, 452 and 411 kg for these three, respective, feeding options. Carcass weights were 237, 237 and 215 kg, respectively. The concentrate savings of 450 kg (by having access to grass only for the first 84 days) resulted in the loss of 22 kg of carcass. Estimate DM concentrate feed conversion efficiency for both *ad libitum* groups was approximately 9:1, but was closer to 8:1 for those animals that had grass only at the start of the outdoor feeding period. The bulls killed out at 536g/kg for the indoor-full-time group and at 524g/kg for the other two groups. Conformation scores were mainly O’s and fat scores of 3 to 3.5.

Table 2. Effect on outdoor period on the performance of bulls fed *ad libitum* or restricted amounts of concentrate

	Barley/ Soya	Pasture + ad lib conc	Pasture + Restricted conc	Sig
Initial weight (kg)	125	126	128	NS
Concentrate intake (kg DM)				
1-112 d	559	511	112	
113-250 d	1019	1051	1030	
1 - 250 d	1578	1562	1142	
Liveweight gain (g/d)				
1-112 d	1390	1420	800	***
113-250 d	1180	1220	1410	***
1 - 250 d	1270	1310	1130	***
FCR (kg concentrate DM/kg gain)				
1-112 d	3.61	3.22	1.26	
113-250 d	6.31	6.26	5.33	
1 - 250 d	4.98	4.78	4.05	
Final liveweight (kg)	442	452	411	***
Carcass weight (kg)	237	237	215	***
KO %	53.6	52.4	52.4	***
Kidney and channel fat (kg)	8.47	8.49	8.46	***
Conformation score[1]	1.89	1.97	1.94	NS
Fat score[2]	3.08	3.47	3.22	*

[1]Based on E=5, U=4, R=3 and O=2 [2]Based on fat score 1 (leanest) to 5 (fattest)

Source: *Fallon, and Drennan, 1998*

Experiment 3 further examined the effects of an initial period (140 days) at grass, with different levels of concentrates on offer, on the subsequent performance indoors. Holstein/Friesian bull calves weighed 114 kg liveweight at the start of the study. The full study lasted 266 days. Calves were offered an *ad libitum* barley/soyabean ration (similar to earlier experiments), either indoors full-time, at pasture for 140 days or were offered 2 kg of this concentrate for 112 days at pasture and then gradually adapted to *ad libitum* concentrates (over 28 days) before the final finishing period of 125 days. For the first 140 days, the indoor calves consumed 711 kg DM in concentrate form, while those on *ad libitum* out doors consumed 640 kg DM (Table 3). Those on the 2 kg allowance consumed 384 kg concentrate DM. Over the final 125 days indoors, concentrate intakes of 872, 919, and 914 kg DM were recorded for the indoor full time, pasture plus *ad libitum*, and, pasture plus 2 kg groups, respectively. Total concentrate intakes were 1583, 1559 and 1298 kg DM for these three groups. The animals which were offered 2 kg concentrates (for the first 112 days) consumed 285 kg concentrates DM less than the *ad libitum* indoor group. Average daily liveweight gains for the initial

140 days were 1.26, 1.34 and 1.07 kg/day for the indoor full time, pasture plus *ad libitum*, and pasture plus 2 kg concentrate groups, respectively. For the final 125 days indoors, these groups grew at a similar growth rate (of approximately, 1.24-1.30 kg/day). Again for these groups, final liveweights were 447, 464, and 419 kg, giving carcass weights of 237, 244 and 216 kg. By allowing access to pasture and offering 2 kg of concentrates / day, a concentrate saving of 285 kg was made, but this was offset by the animals having 21 kg lower carcass weight. Kill out rates were highest for the *ad libitum* indoor group (at 531g/kg) and lowest for the grass plus 2 kg concentrate group (516g/kg). The other group was intermediate. Estimated concentrate feed conversion efficiencies for the *ad libitum* groups were approximately 8.5:1 (kg conc DM/kg carcass) but was better (8:1) for the animals which had access to pasture and restricted concentrates. Carcasses graded O's and P's and had fat scores were approximately 3.

Table 3. Effect on outdoor period at pasture on the performance of spring-born bulls fed concentrates *ad libitum*

	Barley/Soya	Pasture + ad lib conc	Pasture +2 kg conc	Sign
Initial weight (kg)	114	114	114	NS
Concentrate intake (kg DM)				
1 - 140 d	711	640	384	
141 - 266 d	872	919	914	
1 - 266 d	1583	1559	1298	
Liveweight gain (g/d)				
1 - 140 d	1260	1340	1070	***
141 - 266 d	1240	1300	1240	NS
1 - 266 d	1250	1320	1150	***
FCR (kg concentrate DM/kg gain)				
1 - 140 d	4.04	3.40	2.56	
141 - 266 d	5.59	5.60	5.86	
1 - 266 d	4.76	4.44	4.24	
Final liveweight (kg)	447	464	419	***
Carcass weight (kg)	237	244	216	***
KO %	53.1	52.5	51.6	***
Kidney and channel fat (kg)	6.88	6.76	5.10	**
Conformation score[1]	1.85	1.79	1.67	*
Fat score[2]	3.18	2.94	2.85	NS

[1]Based on E=5, U=4, R=3 and O=2 [2]Based on fat score 1 (leanest) to 5 (fattest)

Source: *Fallon, and Drennan, 1998*

15 and 18 month bull beef

The suitability of late winter-born Holstein/Friesian bull calves for beef production was examined in an experiment at Grange. The calves which were purchased at livestock marts were reared indoors initially and then went to pasture for a 223 day grazing season (April 10 to November 19). Average daily gain from arrival to the end of grazing (333 days) was 0.76 kg/day and mean liveweight at the end of the grazing season was 305 kg. They were then housed in a slatted shed and finished on grass silage plus concentrates fed at either 3 kg/day, 6 kg/day or *ad libitum*. Half of the animals on each treatment were slaughtered after 179 days (15 months) while the remainder were slaughtered 93 days later (18 month).

Growth rates

Mean daily gains for various sub-periods and for the total finishing period are shown in Table 4. Gains were higher in the period from 56 to 179 days than before or after. The lower gains in the first 56 days probably reflect the effects of adaptation to housing and the change of diet and also the fact that some of the animals may not have fully reached puberty and maximum testosterone production. The lower gains after 179 days, particularly in the better fed groups, are indicative of animals reaching maturity and having a higher level of fat deposition. It is noteworthy that after 179 days there was no reduction at all in the performance of the animals fed only 3 kg concentrates/day, whereas for those fed 6 kg concentrates/day there was a reduction of 142 g/day (10%) and for those given concentrates *ad libitum* the reduction was 195 g/day (14%). Mean liveweights after 179 days for the 3 kg/day, 6 kg/day and *ad libitum* concentrate groups were 467, 515 and 550 kg, respectively. Basically these data indicate that the daily growth rate of Holstein/Friesian young bulls, which have been fed to grow fairly rapidly over the previous 6 months, starts to decline after about 500 kg liveweight and the rate of decline increases with increasing weight and previous feeding level.

Overall mean weight gain for the 3 kg/day, 6 kg/day and *ad libitum* concentrate feeding levels was 908, 1164 and 1395 g/day, respectively up to 179 days and 961, 1022 and 1200 g/day afterwards. For the experiment as a whole mean performance was 914, 1141 and 1358 g/day, respectively for the treatments as listed.

Table 4. Daily gains of young bulls during finishing

	Concentrate level (kg/day)		
Daily gain for (g):	3	6	*ad libitum*
Days 0 – 56	714	910	1228
56 – 112	866	1108	1429
112- 179	1106	1425	1508
0 – 179	908	1164	1395
179 – 272	961	1022	1200
0 – slaughter	914	1141	1358
Carcass gain (g)	598	741	895

Source: *Keane and Fallon, 2001*

Slaughter traits

Slaughter traits are shown in Table 5. Slaughter weight ranged from 467 kg for the animals fed 3 kg/day concentrates for 179 days to 670 kg for those fed concentrates *ad libitum* for 272 days. Corresponding carcass weights were 241 to 377 kg. Thus, the experimental treatments used here can be considered as a range of practical production options for the production of bull beef carcasses any desired weight within this range. Kill-out increased with increasing feeding level and slaughter weight. At the 3 kg/day feeding level, it averaged 531 g/kg. This increased to 541 g/kg at the 6 kg/day feeding level and to 554 g/kg at the *ad libitum* feeding level. It is likely that this increased kill-out was due more to increased slaughter weight than to higher feeding level per se. There was a big increase in kill-out due to the longer feeding period particularly for the lower feeding levels. The mean increase was 24 g/kg but this ranged from 29 g/kg for the 3 kg/day group down to 19 g/kg for the *ad libitum* group. Because of this increased kill-out in the animals retained for 272 days, the decrease in carcass gain after 179 days was relatively less than the decrease in liveweight gain. While the mean decrease in liveweight gain after 179 days was 169 g/day (13%) for the 6 kg/day and *ad libitum* groups (there was no decrease for the 3 kg/day group because they were still relatively light), the mean decrease in carcass gain was only 72 g/day (9%). Thus, any economic assessment of various finishing periods and slaughter weights must offset the increasing kill-out against the decreasing liveweight gain which occurs as the length of finishing and slaughter weight increase.

Table 5. Slaughter traits of young bulls finished on 3 feeding levels for 2 periods.

Concentrates (kg/day)	3		6		*ad libitum*	
Age (months)	15	18	15	18	15	18
Finishing period (days)	179	272	179	272	179	272
Slaughter weight (kg)	467	562	515	607	550	670
Carcass weight (kg)	241	307	272	336	300	377
Kill-out (g/kg)	517	546	529	553	544	563
Conformation	2.0	2.3	2.2	2.9	2.6	3.1
Fat score	2.9	2.9	2.9	3.2	3.1	3.2

Source: *Keane and Fallon, 2001*

Carcass grade improved with both increasing feeding level and length of finishing. Animals on the 3 kg/day concentrate level for 179 days averaged "O" whereas those on the *ad libitum* concentrate level for 272 days averaged "R". Again the effect is likely to have been due to carcass weight more so than feeding level or feeding period. It can be estimated that conformation improved by one class per 120 kg increase in carcass weight. Fat score was relatively little affected by either feeding level of finishing period and averaged about 3.

Feed intakes and efficiency

Silage and concentrate intakes for the total finishing period are shown in Table 6. Concentrate intakes ranged from 0.5 tonne for animals fed 3 kg/day for 179 days to 3.0 tonnes for animals fed *ad libitum* for 272 days. Silage intakes ranged from less than 1.0 tonne for animals fed *ad libitum* to almost 8 tonnes per animals fed 3 kg/day concentrates for 272 days. Since silage and concentrate intakes and liveweight gains varied with treatment, it is necessary to bring the feeds to some common denominator to get an estimate of efficiency. In all cases efficiency was poorer for those fed for 272 days than for those fed for 179 days, emphasising the importance of keeping the feeding period short. Otherwise the poorest efficiency occurred at the 3 kg/day concentrate feeding level with no difference between the 6 kg/day and *ad libitum* feeding levels.

While mean fat score did not differ greatly between the treatments, it is likely that in practice a high proportion of the animals fed on 3 kg/day of concentrate for both the 179 and 272 day periods would be insufficiently finished.

Table 6. Feed intakes of young bulls during finishing

Concentrate level (kg/day)	3		6		*ad libitum*	
Age (months)	15	18	15	18	*15*	*18*
Finishing period (days)	179	272	179	272	179	272
Concentrates (kg)[1]	516	795	1032	1590	1763	2988
Silage (t)[2]	4.52	7.82	3.06	5.62	0.90	1.36
Liveweight gain (kg)[3]	160	255	210	302	246	365

[1]Fresh weight corrected to 860 g/kg dry matter (DM); [2]Fresh weight corrected to 200 g/kg DM;
[3]Actual gains during finishing

Source: *Keane and Fallon, 2001*

Therefore, the treatments of greatest relevance are 6 kg/day and *ad libitum* concentrates. If all animals were taken to a minimum slaughter weight of 550 kg giving a carcass of about 300 kg, the feed inputs necessary would be 1.3t concentrates plus 4.2t silage for animals fed 6 kg/day concentrates, and 1.8 tonnes concentrates plus 0.9t silage for animals fed *ad libitum* concentrates.

Steer beef from Holstein/Friesian steers at 24 months of age

Rearing Holstein/Friesian males as steers has been practiced widely in Ireland. The typical inputs and outputs from such a system are summarised in Tables 7 and 8. The typical system uses one tonne of concentrates per animal unit, 75 per cent of which is fed in the final finishing phase. Approximately 80, 60 and 110 kg of concentrates are fed during the indoor calf rearing stage, at grass in year one and during the first winter as weanlings, respectively. Winter forage (grass silage) requirement is 1.5t DM/animal unit, where 0.5 and 1.0t DM are fed in the first and second winter, respectively. Winter feed requirements are met by cutting approximately 55 per cent (or more) of the area for silage in late May, and, depending on stocking rate, a further 40 per cent in late July. Grazed grass requirement is approximately to 2.5t DM/calf plus yearling unit. Matching feed supply to herd demand for the full year, suggests that a stocking rate of 1.8 and 2.9 units (calf plus yearling)/ha can be carried within the 170 and 250 kg organic nitrogen limits.

Table 7. Summary of inputs for spring-born Holstein-Friesian steers in a two-year system

	Inputs (REPS-4 standard)	Inputs (Derogation level)
Per head		
Concentrates (kg)		
Calf indoors	80	80
Calf at pasture	60	60
1st winter as weanlings	110	110
2nd winter- finishing	750	750
Total	**1000**	**1000**
Grazed grass (kg DM)		
1st grazing season	660	660
2nd grazing season	1790	1790
Total	**2450**	**2450**
Silage (kg DM)		
1st winter	500	500
2nd winter	960	960
Total	**1460**	**1460**
Land areas		
ha/animal unit	0.55 (0.33 ha cut and 0.25 ha grazed)	0.35 (0.22 ha cut once, 0.2 ha cut twice)
Animal units/ha	1.8	2.9
Carcass output (kg/ha)	**580**	**930**

Typical target liveweights for the system are 230 kg at first housing, 300 kg at turnout in spring and 490 kg at housing at the one and a half year-old stage. Lifetime daily gain (birth to slaughter) will be around 0.8 kg/day. Weanling normally grown at about 0.5-0.6 kg/day during their first winter and this is done to lower production cost and to optimise subsequent performance at pasture (compensatory growth). Managing calves and yearling at grass requires a balance between getting good daily gains and high grass utilisation. The practice of a leader-follower system, where calves graze ahead of the older animals, is often used. This system allows the calves the opportunity of unlimited access to quality pasture. Holstein/Friesian steers should be 620 kg liveweight at 24 months of age and yield a carcass of 320 kg. Typical carcasses will grade 80 per cent O's and 20 per cent P's and the fat scores will be 50:50 mix of 3's and 4's.

Table 8. Target live weighs and liveweight gains for spring-born Holstein-Friesian steers in a two-year system

Date	No of days	Gain (kg/day)	Live weight (kg)	Live weight (kg)	Carcass weight (kg), conformation and fat score
March 15th				45	
May 12th	58	0.6	35	80	
Nov 17th	189	0.8	150	230	
March 23rd	126	0.55	70	300	
Oct 19th	210	0.9	190	490	
March 15th	147	0.9	130	620	
Total/Mean	**730**	**0.79**	**620**	**620**	
Carcass weight				320 (KO 516g/kg)	
Conformation Fat Score					80% O's, 20% P's 50% 3's, 50% 4's

Calf Health

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Summary

- A well planned herd health programme is an effective tool to prevent disease.
- Pay particular attention to nutrition, environment, sanitation, and care of the newborn calf.
- A well planned and consistent vaccination programme is an effective tool to prevent scours and pneumonia in calves but is not a replacement for good management, good hygiene or good biosecurity.
- Multiple studies show that poor colostrum quality and feeding management markedly increases morbidity and mortality in calves.
- The time of first milking after calving is the most crucial factor regarding colostrum quality.
- Calves should be housed in well ventilated, draught-free, easily cleaned accommodation with plenty of clean dry bedding.
- Calf neonatal mortality and disease has very important welfare implications and is the cause of substantial economic loss to the agricultural industry.

Introduction

The aim of successful calf rearing is to produce a healthy calf which is capable of optimum performance throughout its life from birth through to finishing. A suitable calf rearing system has the following characteristics:

- Good animal performance with minimal disease and morbidity
- Low cost input
- Low labour input

To ensure a healthy calf, the aim is to minimise the calf's exposure to disease, and maximise its defence against disease. In minimising a calf's exposure to disease, providing a clean, disease-free environment is fundamental. This involves:

- Thorough cleaning and disinfection, before and during the calving season, of all areas used by calves.
- Providing a clean, straw-bedded lying area with no draughts and good ventilation.
- Accommodating calves in batches so that young calves are never mixed with or accommodated in areas used by older calves.

The objective of a well-designed herd health programme is to address multiple areas of management in order to reduce the likelihood of disease outbreaks and is a necessary step if economic returns are to be realised. A herd health programme that includes bio-security, vaccination and the culling of carrier animals, drawn up in consultation with a veterinary practitioner, is the best way to address disease problems.

Infectious disease agents

Calf scours

Scours are the main causes of calf mortality. The majority of calf scours are caused by six organisms: viruses such as rotavirus and coronavirus, bacteria such as *E. coli* and *Salmonella* sp., and protozoa, such as cryptosporidia and coccidia. As outlined above, vaccination of the dam will help reduce the probability of calf scours but cannot solely be depended upon for prevention. Furthermore, there are no vaccines available to combat protozoa. However, good hygiene and management practices will reduce the likelihood of infection from cryptosporidia and coccidia. Diarrhoea in calves results in losses of water and electrolytes, such as sodium, bicarbonate, chlorine, and potassium. Calves with diarrhoea can lose 10-12 per cent of their body weight in water losses. Depending on the severity of the diarrhoea and dehydration, calves may need to receive oral electrolyte solutions once daily or as many as four times a day. Calves should be fed their regular allowance of milk when receiving oral electrolytes. Scientific evidence has accumulated that continued milk feeding does not worsen or prolong the course of diarrhoea, despite a somewhat lowered digestive capacity. The milk supplies the calf with energy and other nutrients that are essential for survival.

Calf pneumonia

The underlying cause of pneumonia or bovine respiratory disease (BRD) is extremely complex with the involvement of viruses, bacteria and mycoplasma. The incidence of infection is usually high, but the mortality rate is variable. The main viruses that cause outbreaks of pneumonia in calves are IBR, RSV, PI-3, and BVD. Factors associated with susceptibility to pneumonia in calves are; stress (disbudding, castration), overcrowding, inadequate ventilation, draughts, fluctuating temperatures, poor nutrition and/or concurrent disease. In most cases the main infective agent is a virus, which causes respiratory tract damage. This effect is worsened by Mycoplasmas and secondary bacterial infections *(e.g. Mannheimia (Pasteurella) haemolytica)*. Viruses are unaffected by antibiotics, however, antibiotic treatment is usually administered to kill off the secondary bacterial infections and offer the calf the opportunity to fight the disease. In order to direct the appropriate treatment strategy, nasal swabs should be submitted to the Regional Veterinary Laboratory for accurate identification of the pathogen(s) involved. Calves should be vaccinated where specific problems arise. Veterinary advice should be sought and the widest protection against pneumonia will be achieved where a vaccination programme includes the three most common respiratory viruses (IBR, RSV and PI-3) and the bacterial pathogen *Mannheimia (Pasteurella) haemolytica*.

Calf immunity

In the bovine species, immunoglobulins do not cross the placenta *in utero*, and the newborn calf is, therefore, dependent on antibodies obtained through ingestion of colostrum. Maternal colostrum provides the main source of immunoglobulins (Ig) and other nutrients for the newborn calf. If the serum immunoglobulin concentration is less than 10 mg/ml when sampled between 24 and 48 h of age, calves may be defined as having failure of passive transfer (FPT) of protective colostral immunoglobulins. Calves that receive inadequate colostrum are more susceptible to neonatal infections. This problem can be particularly severe in calves that have been moved off their farm of origin and through markets. In these circumstances, there is greater risk of exposure to infection. Foetal growth retardation or a stressful birth process is likely to reduce the ability of the intestine to absorb immunoglobulins from colostrum.

Variation in immunoglobulin concentration

Immunoglobulins help to maintain the animal's health and reduce mortality rates by helping to eliminate foreign agents in the body (e.g. bacteria and viruses). Considerable variation exists between cows with respect to immunoglobulin concentration in the colostrum. No significant difference between colostrum IgG1 concentrations in either the front or hindquarters of the udder have been reported however, a large variation in colostrum yield exists between beef and dairy cows (Table 1). Research at Teagasc, Grange has clearly shown that dairy calves with low levels of immunoglobulins had the highest incidence of diarrhoea, respiratory disease and mortality compared with age matched suckled beef calves (Earley *et al.,* 2000). This is primarily due to the much lower concentration of IgG in colostrum of dairy cows compared with suckler cows.

Table 1. Mean colostrum IgG (mg/ml) concentration from the front and back quarters of the udder

Cow breed	Front quarter IgG (mg/ml)	Back quarter IgG (mg/ml)
Charolais × beef breed	164	177
Limousin × beef breed	166	165
Hereford × beef breed	170	171
Simmental × beef breed	169	168
Holstein-Friesian	85	88

Source: *Earley and Fallon (1999)*

Factors influencing immunoglobulin concentrations in calf serum

The main factors influencing immunoglobulin concentrations in calf serum are: (1) Time of feeding/suckling, (2) Volume of ingested colostrum and (3) Immunoglobulin concentration in colostrum. Consequently, with regard to colostrum feeding, there are a number of main points which must be noted.

Time of feeding

- The immunoglobulins in colostrum must get into the calf's blood via absorption from the small intestine.
- The ability of the calf to absorb these immunoglobulins decreases linearly after birth and generally stops by 24 hours of life.

This means that the earlier a calf is fed/suckles after birth the greater the level of immunoglobulin absorption. Ideally, the calf should ingest colostrum within one hour of birth. There are also advantages in continual colostrum ingestion after the first day as the immunoglobulins in colostrum also acts locally in the gut and helps fight against septicaemia.

Colostrum - feeding procedures

It is well recognised that the oesophageal groove reflex is not triggered when colostrum is administered by the oesophageal tube method and this results in colostrum deposition in the forestomachs. In contrast, when a nipple bottle or bucket is used, suckling triggers the oesophageal groove reflex, resulting in the deposition of colostrum directly into the omasum and abomasum, where it can quickly empty into the small intestine to be absorbed. The ability of the intestines to absorb IgG starts to decline progressively after 4 to 6 hours and ceases after 24 hours from birth. This means that the earlier a calf is fed / suckles after birth the greater the level of immunoglobulin absorption. Current recommendations for normal sized dairy calves are to administer either 3 L of good quality colostrum within 1-2 hours of birth by oesophageal tube (Chigerwe *et al.,* 2008) or to ensure that calves receive at least 2 L within 4 hours by nipple feeding and a total of 4 L within 12 hours from birth (Chigerwe *et al.,* 2009).

Research studies – calf health

In a Teagasc study, 93 Charolais×Friesian (Ch×Fr), 30 Limousin×Friesian (Li×Fr) and 100 Holstein-Friesian (HF), calves were purchased directly from marts and were approximately 21 days of age on arrival at Teagasc, Grange Research Centre. Calves with a rectal temperature greater than or equal to 40°C and clinical signs of pneumonia were administered antibiotic for the treatment of clinical symptoms (defined individually for each animal). Fifty-four out of a total of the 223 purchased calves remained healthy throughout the 63 day rearing period indoors (Table 2). The incidence of respiratory disease was higher in calves with low serum Ig levels and ZST units. Calves with low immunoglobulins (less than 10 ZST Units; less than 21mg/ml total serum Ig) are more susceptible to respiratory disease.

Table 2. Frequency of antibiotic treatment for pneumonia in purchased dairy calves

	0	1	2	3	4 or more
Charolais×Friesian					
Number of calves treated	15	25	20	17	16
% of Total	16	27	22	18	17
Mean ZST[1] (day 0)	10	9	9	8	9
Limousin×Friesian					
Number of calves treated	16	7	4	2	1
% of Total	53	23	13	7	3
Mean ZST (day 0)	10	7	11	10	11
Holstein-Friesian (n=100)					
Number of calves treated	23	29	24	14	10
% of Total	23	29	24	14	10
Mean ZST[1] (day 0)	8	7	7	9	6

[1]ZST Units are shown for calves at arrival in Grange on day 0.

Source: *Earley and Fallon (1999)*

In another Teagasc study, Earley *et al*. (2000) quantified serum immunoglobulin concentrations in suckled beef calves and dairy calves. The spring-calving suckler herd at Grange was the source of suckled calves. This herd, which calved indoors, consisted of the following breeds: Charolais, Simmental×(Limousin×Friesian) and Limousin×Friesian. The calves were either by a Charolais or Limousin bull and consisted of: Continental types (representing the progeny of Charolais cows by either Charolais (n = 8) or

Limousin bulls (n=8)), ⅞Continental×⅛Friesian (representing the progeny of the Simmental×(Limousin×Friesian) cows and Charolais bull) and ¾Continental×¼ Friesian (representing the progeny of the Limousin×Friesian cows and Charolais (n=52) or Limousin (n=12) bulls). Calves were then left with their dam and blood sampled 28 and 56 days post partum. Male spring-born calves from dairy herds were purchased from auction marts and consisted of Charolais×Friesian (n=61), Limousin×Friesian (n=39), Belgian Blue×Friesian (n=9), and Holstein-Friesian (n=73). The dairy calves were approximately 28 days of age on arrival at Teagasc, Grange Research Centre. They received an individual allowance of 25 kg of milk-replacer powder, offered warm (38^{o}C) by bucket (125 g/1), during the first 42 days and had *ad libitum* access to a concentrate ration during the first 56 days after arrival. Serum samples were collected from the dairy-herd calves on days 0 (day of arrival) and again 28 days later. Serum samples were collected from the suckled calves 28 and 56 days post partum. The total Ig serum concentrations and ZST units were significantly higher in the suckled calves compared with the purchased calves at 28 and 56 days of age. In the present study, all suckled calves were individually fed 40 ml of first milking colostrum per kg of birth weight from the calf's own dam, within one 1 h of birth, using an oesophageal feeder and bag (stomach tube). The purpose of this procedure was to ensure suckled calves received an adequate quantity of Ig of known quality (> 160 mg IgG/ml) in the immediate post-partum period. The colostrum feeding procedure for the dairy-herd calves used in the present study was unknown. The marked differences in total Ig concentrations between suckled calves and purchased calves suggest that calves born in dairy herds received either insufficient quality or quantity of colostral immunoglobulins.

Research studies - requirements of the housed calf

The reasons for housing artificially reared calves are mainly management ones. The calf born outdoors is capable of finding its own shelter. In the confinement of a house, away from its mother, the calf needs to be provided with:

- A dry surface to lie on
- Protection from draughts
- Adequate ventilation

If these criteria are met the healthy calf should be insensitive to weather changes outside the house, i.e. temperature, humidity and wind speed.

Dry, draught free housing will reduce the environmental stresses on calves and adequate air changes resulting from good ventilation reduce the infection load on the calves. It may not prevent pneumonia. However, the severity of pneumonia will be less and the mortality associated with it will be reduced. From an animal health and welfare viewpoint it is important to develop a combination of management procedures which will minimise the adverse effects of respiratory disease on calf performance and health/ welfare indicators. The effects of rearing calves outdoors using calf jackets on performance and immune responses with a view to developing management procedures to improve the health and welfare of calves was investigated in a study at Grange. The study showed that rearing calves outdoors using calf jackets had no beneficial effect on calf performance. The incidence of respiratory disease was higher in calves reared indoors when compared with calves reared outdoors with and without jackets. There was an increased incidence of diarrhoea in calves reared outdoors irrespective of calf jacket (Earley *et al.,* 2004).

The choice of calf house will depend to a large extent on the size of the enterprise and on labour availability, feeding system, penning arrangement and intensity of use. Ideally the calf house should meet the environmental requirements of the calf and accommodate the feeding routine of the rearer.

A number of studies at Teagasc, Grange have shown that there was no significant difference in calf performance between the naturally ventilated calf house and the calf hutches. While there was a significant reduction in the number of calves treated for respiratory disease among calves reared in hutches (58% versus 43%), it was evident that the isolation provided by the hutches did not markedly reduce the incidence of respiratory disease among bought-in calves which may already have been exposed to infectious organisms (Fallon, 2009).

A series of four experiments used 320 calves to compare a conventional naturally-ventilated calf house with a similar sized building where ventilation was provided by a fan system which forced air into the building. On arrival at Grange the calves were allocated to the following treatments:

1. Climatic naturally ventilated calf house
2. Fan ventilated - forced air, calf house

There was no difference between houses in the incidence of disease, mortality, feed intake or liveweight gain in any of the four studies. It was concluded that the fan system which forced air into the building gave similar calf performance to a naturally ventilated building irrespective of disease challenge.

Conclusion

Calves are exposed to infectious organisms from the moment of birth, and natural defence mechanisms usually prevent the establishment of disease. Animals develop disease because of a complex relationship between the host (animal), the infectious agent (bacterium, virus etc), and the environment. Control of the agent is largely based on prevention of exposure, immunity, and chemotherapeutic (drugs) agents. In maximising a calf's defence against disease, control measures include:

- Adequate nutrition of the pregnant cow.
- Vaccination of cows for control of any organism(s) known to be responsible for infection on the farm in calves e.g. *E. coli, Salmonella*, rotavirus and coronavirus. In this respect, vaccination alone is not a replacement for good management, good hygiene or good biosecurity.
- Disinfecting the calf's navel immediately after birth.
- Pooling of colostrum is discouraged for biosecurity reasons.
- Ensuring that each calf receives sufficient colostrum (first milk) immediately after calving. Colostrum provides not only food but also maternal antibodies (immunoglobulins) to protect the young calf against the common infections that it is likely to encounter in early life.
- Regular temperature checking is useful to guide both diagnosis and observation of a clinical problem.
- A veterinary practitioner should always be consulted with regard to specific health problems.

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Economics of Beef Production from Holstein/Friesian male calves

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Summary

- Holstein/Friesian bull calves when finished as either bulls or steers offer the potential to rear and finish an increased number of cattle per hectare and hence increase the gross output of a farm.
- With bulls slaughtered at a younger age a higher number can be finished per ha giving much higher carcass output / ha compared to steer calf to beef systems.
- The higher the number slaughtered per ha the more sensitive the margins are to changes in calf purchase price, concentrate price and beef selling price.
- Young bulls finished for the red veal market at under 12 months of age on *ad-libitum* concentrate diets have the potential to make a gross margin at current contract sale prices of €50/head.
- Holstein/Friesian bulls finished at 15 months of age after grazing for one season have the potential at current market prices of generating a gross margin of just over €950/ha.
- Where bulls are grazed for half of the second grazing season before being finished over a short period on *ad-libitum* concentrates indoors the current potential gross margin rises to almost €1,100/ha.
- When Holstein/Friesians are finished at high stocking rates in a conventional calf to two year steer beef system the potential gross margin is €920/ha.
- There is on going research at Teagasc, Johnstown Castle Research Centre as part of the Teagasc /Dawn Meats joint initiative on dairy bred calf to bull beef systems. Data from this work will provide information on a range of bull beef systems. The potential margins / ha for each system will be an important part of the results from this work.

Introduction

The majority of dairy bred male calves born in this country are either finished as steers on dairy farms at 24 to 30 months or exported live to the continent at less than one month of age. In recent years there has been an increased interest in finishing these animals as bulls as they can be slaughtered at much younger ages than steers and have the potential to increase significantly a farm's output. Markets have also been developed (although limited in quantity) for under 12 month bull beef which has led to production systems that involve finishing dairy bred calves at low carcass weights while receiving a premium price.

The profitability of any beef system is a combination of the margin achieved per animal finished or sold and the number sold or finished per hectare. With an earlier slaughter age, bull beef production systems offer the potential to rear and finish an increased number of cattle per hectare farmed. The younger the slaughter age the more that can be finished per ha. With many of the bull beef systems the limit on a farms stocking rate will in most cases be either the housing that is available on the farm or the carrying capacity on the grazing area at critical times of the year rather than the limits imposed under the Nitrates Directive.

As dairy bred bull beef production systems involve finishing high animal numbers per hectare the profitability of the systems operated is quite sensitive to changes in calf purchase price, concentrate price and the slaughter price. Systems that have a higher proportion of grass in the lifetime diet of the animals are not as sensitive to these variables as numbers per unit area are less and they consume less concentrates. The purpose of this paper is to look at the potential margins for a number of different dairy bull beef systems and also the typical two year steer system. The assumptions used for inputs and outputs are based on the results from many different experiments carried out in Teagasc, Grange over the years on both dairy born bulls and steers. On-going research as part of the Teagasc / Dawn Meats dairy calf to beef initiative in Teagasc, Johnstown Castle will be examining many of these systems in more detail and will provide more data over the coming years on the inputs used and the outputs achieved both per head and per hectare which will form future economic analysis.

Under 12 Month Bulls

Current systems of under 12 month bull beef are based on the production of red veal from Holstein/Friesian bull calves. Bull calves are reared in conventional calf rearing systems on milk replacer, calf ration and straw/hay to 12 weeks of age. Intakes of ration are increased to *ad-libitum* with straw as a roughage source and they are kept indoors through to slaughter. In some cases maize silage can make up some of the diet if it is of a high enough dry matter and starch content. Carcass weights range between 200 and 220 kg and a finishing price per kg carcass weight is agreed eight months in advance at the start of the finishing period.

The advantages of this system are that large numbers of bull calves can be finished once there is the housing available to accommodate them. This system has also built up around farmers buying reared calves at 12 weeks of age from specialised calf rearers which allows them to finish much greater numbers without the need to rear calves through to weaning themselves. Inputs and performances with *ad-libitum* concentrate systems are very predictable and repeatable but they are also the most sensitive to changes in calf purchase price, concentrate price and sale price.

Table 1 shows the current economic figures for a 11 month red veal system. This is based on a calf purchase price of €100, a concentrate price of €220/t (for finishing period) and a contracted sale price of 330 cent/kg, which results in a potential gross margin of €50/head from this system. However, any further rises in concentrate prices would leave this system with little or no gross margin per head. With calves slaughtered at between 11 and 12 months of age there is the potential to finish 10 calves/ha. Housing availability though is more likely to be the limiting factor in determining the numbers finished.

15 Month Bull Beef

At current commercial beef prices and carcass specification requirements the Holstein/Friesian bull can be finished at 15 to 16 months of age. Spring born bulls are grazed throughout the summer and autumn and housed at the end of October or early November. They are then housed and finished on either very good silage and concentrates or on *ad-libitum* concentrates with a small amount of roughage.

Table 1. Finishing Holstein/Friesian bulls under 12 months of age

Assumptions	
Calf Purchase Price	€100
Calf Mortality	5%
Calf Rearing Costs	€100
Concentrate Cost / ton	€220
Slaughter Weight	400 kg
Carcass Weight	208 kg
Sale Price c/kg cw	330 c/kg
Revenue	
208 kg Carcass	€686
Less Calf Purchase (+ mortality)	€105
Net Income	**€586**
Variable Costs	
Calf Rearing (incl. concentrates)	€100
Finishing Concentrates	€359
Straw	€24
Veterinary	€22
Marketing & Transport	€15
Interest	€16
Total	**€536**
Gross Margin per Head	**€50**
Sensitivity Analysis on Margin	
Calf purchase price +/- €30/hd	+/- €32
Concentrate Price +/- €30/ton	+/- € 49
Selling Price +/- 30c/kg	+/- €62
Mortality +/- 3%	+/- €11

Table 2 outlines the economics of this system. At 15 months carcass weight is 272 kg. This may need to be higher if bulls are more extreme Holstein types as conformation and fat score may be poor at this carcass weight. This would involve lengthening the finishing period by a further 30 days. It is assumed with these figures that silage quality is excellent and an average of 5.8 kg of concentrates is fed per day. Where silage quality is not excellent *ad-libitum* feeding of concentrates would be the preferred option which may increase the finishing costs further and hence reduce the margins.

Table 2. Finishing Holstein/Friesian male calves as bulls at 15 and 18 months or steers at 24 months

	15 Months		18 Months		Steer 24 Months	
Assumptions						
Beef Price (c/kg)	300		300		300	
Finishing Concentrate price (€/t)	220		220		220	
Urea Price (€/t)	375		375		375	
CAN Price (€/t)	275		275		275	
Calf price (€)	100		100		100	
Stocking rate LU/ha	2.9		2.8		2.9	
Animal units per ha	5.8		4.2		2.8	
Whole farm organic N (kg/ha)	230		229		230	
Sales of cattle/finishers (40 ha)	228		166		110	
Carcass weight (kg)	272		307		319	
Output (kg carcass weight/ha)	1550		1276		874	
Concentrate per animal unit (kg)	1,538		1,653		1,040	
Financial Budgets	**Per ha**	**Per head**	**Per ha**	**Per head**	**Per ha**	**Per head**
RECEIPTS						
Livestock	4,733	816	3,868	921	2,680	957
Livestock purchases	603	106	449	108	293	107
Gross Output	4,130	724	3,419	822	2,387	850
VARIABLE COSTS						
Concentrates	2,140	369	1,667	397	675	247
Grassland (fert., lime & reseed)	129	22	130	31	126	46
Milk replacer,	193	34	142	34	95	34
Silage making(con, fert, poly etc)	404	70	159	38	392	140
Vet & Medicine	307	53	248	59	172	63
Total Variable Costs	3,173	548	2,346	559	1,460	530
Gross Margin	**957**	**176**	**1,073**	**263**	**927**	**320**
Fixed Costs	361	63	375	90	323	118
Depreciation	374	66	277	66	231	84
Total Farm Costs	3,908	677	2,998	715	2,014	732
Net Margin	**222**	**47**	**421**	**107**	**373**	**118**
Labour						
Assume 1 labour unit per 300 animal units valued at €25,000 per labour unit	480	84	352	84	232	84
Net Margin less labour costs	-258	-37	69	23	141	34
Sensitivity Analysis on Margins	+/-	+/-	+/-	+/-	+/-	+/-
Calf price +/- €30 / head	€180	€31	€135	€32	€87	€32
Concentrate Price +/- €30 / t	€182	€32	€160	€38	€74	€27
Beef Price +/- 30 c / kg	€477	€83	€375	€90	€267	€98

Gross margin per head is low at €176 but there is a high number finished per ha at 5.8. This results in a gross margin/ha of €957. The fixed costs associated with this system are high due to the high numbers being fed over the winter and the increased housing required. When fixed costs (€735/ha) are included in the analysis, the net margin becomes €222/ha (not including labour costs).

The margins in this system are also very sensitive to small changes in calf price, meal price and beef selling price. A high performance per head at each stage of the production cycle is also essential otherwise the costs are higher in the finishing period or the carcass weights achieved are lower. There is also a high labour demand with this system of beef production due to the high number of bulls finished per ha. Including a labour charge helps to demonstrate the differences there are with the different systems of production.

18 Month Bull Beef

To increase the amount of grass in the bulls' lifetime diet while at the same time increasing carcass weight and reducing the number of bulls finished per ha the option of finishing bulls at 18 months of age should be considered. With this system Holstein/Friesian bull calves are grazed until mid-November when they are housed and fed silage plus 2 kg concentrate. They are then turned back out to grass in February / March and grazed for a further 100 days on high quality leafy swards and moved regularly. Towards the end of May early June they are housed and finished on *ad-libitum* concentrates for over 100 days.

The economics of this system are outlined in Table 2. Compared to the 15 month bull finishing system the number of animals finished per ha drops to 4.2 bulls. The variable costs per head are similar but the carcass weight is considerably higher at 307 kg adding over €100/head to the margin. This system requires excellent grassland management especially in the second year at grass. Performance over the winter as weanlings is also important as they are expected to gain at least 0.7 kg/day. For this to be achieved silage quality needs to high.

The gross margin per head is €263 giving a gross margin per ha of €1,073. The fixed costs for this system are also high, due to the large number of bulls finished per ha. Which leaves this system with a net margin per ha of €421(not including labour costs). The labour charges per ha are lower than the 15 month bull system.

Two Year Steer Beef

The inputs and performances associated with finishing Holstein/Friesians as steers at 24 months of age are well documented. On many well run farms these targets are being met. Typically, a 320 kg carcass is produced from two summers at grass and two winters. Most finishing systems are based on a final finishing period to gain 120 to 140 kg of liveweight which is achieved by either excellent grass silage with 4 - 5 kg of meal or *ad-libitum* concentrates plus a minimum of roughage.

The economics for this system when it is operated at a high stocking rate are shown in Table 2. In this system, 2.8 calves are purchased per ha per annum. In the final finishing period animals are fed silage and concentrates. At a high stocking rate this system can achieve a gross margin of just over €900/ha. Again grassland management needs to be good otherwise the final finishing phase can be too long with a subsequent dramatic rise in input costs. With the lower numbers finished per ha there is not the same demand on fixed costs and housing compared to some of the bull beef systems which leaves this system with a net margin per ha of €373 (not including labour costs). The labour costs are also lower due to the lower stocking rate.

A variation of the two year steer system is bulls finished at 21 – 22 months of age. This system is similar to the two year steer system but the bulls are housed earlier and finished earlier than the steers. As they are bulls they also have a higher daily gain over the finishing period which usually results in a higher carcass weight compared to the steer system. However, unlike the other bull beef systems they remain at grass for the majority of the second grazing season and this can present management as well as health & safety issues making this system less attractive for many farmers.

Conclusion

Holstein/Friesian bull calves can be finished in bull and steer systems generating gross margins of between €900 and €1,100/hectare. High stocking rates and high animal performance are essential components of each of the systems. With high numbers finished per ha the bull systems are more sensitive to changes in calf purchase price, concentrate price and selling price per kg of carcass when compared to the two year steer finishing system. The availability of existing housing on a farm will determine the number that can be finished per ha rather than Nitrates Directive stocking limits. The bull and steer systems offer the opportunity for both dairy and beef farmers to significantly increase their farms gross output.

High Concentrate Diets for Dairy Bulls

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Introduction

Finishing bulls on high concentrate diets is a high cost system with a large input of concentrate feeds. For the system to be profitable concentrates must be cheap and calves must be relatively cheap and of high growth potential. This system requires careful diet formulation and excellent feeding management to ensure maximum performance and minimum risk of digestive upsets. This paper will outline target intake levels as well as guidelines on diet formulation and appropriate feeding management.

Target Weight Gain

Table 1 outlines guidelines for liveweight gain (LWG) on different classes of finishing animal. At best, this is a guideline to target gains as actual LWG will be dictated by a number of factors including the previous history of the animal, weight for age, diet type, feeding management, husbandry etc.

The scope for compensatory growth depends on the previous nutritional history of the animal. Lifetime performance to the start of the finishing period will have a major bearing on animal performance over the finishing period. The lighter an animal's weight for age, the greater the animal's potential for compensation. Differences in compensatory growth potential can result in big variations in response to concentrates. Animals with little compensatory growth tend to have poorer performance and efficiency.

Table 1. Suggested target weight gains for finishing bulls offered diets with different concentrate proportions

	Proportion of Concentrate : Forage	
	50:50* LWG kg / day	90 : 10 LWG kg/day
Friesian	1.1	1.2-1.3
Continental Cross	1.2	1.5

*Assumed silage quality of 72 DMD plus 4-5 kg meals for steers and heifers, for bulls it is assumed that silage is constituting 35 per cent of the total DM content with the remainder as concentrates.

Duration of the finishing period

Unlike steers, where performance starts to decline after 80-90 days on *ad-libitum* meals, young bulls have been successfully fed for up to 270 days, but rate of gain declines significantly over time. The duration of the meal feeding period will be dictated by the start weight, carcass weight required, level of fatness and other factors such as lameness, particularly for bulls on slats. It will also depend on where an animal is on the growth curve. Animals with a lot of growth potential might be expected to continue thriving for longer than an animal with high lifetime performance to that point. As a rule of thumb a maximum feeding period of 170-180 days is preferable. Starting weight for high concentrate feeding of dairy bulls will be dictated by target slaughter weight but assuming a liveweight gain of 1.25 kg / day, animals should be within 220 kg of slaughter, when high concentrate feeding begins. High rates of gain over short periods of time are very efficient, all else being equal.

Dry Matter Intake

Achieving high dry matter intake is essential for good performance. Table 2 outlines the level of intake achieved by dairy bulls in research studies at Teagasc, Grange. Young calves at 12 weeks (Batch 1) on an *ad libitum* concentrate diets achieved an intake of 2.8 per cent of body weight but this declined significantly over the next 140 days. The overall intake from 110 kg to 442 kg body weight (Batch 2) was 2.2 per cent of body weight. On average, heavier animals might be expected to achieve 2.0-2.1 per cent of body weight on an *ad libitum* feeding system. Experience would suggest that dairy bulls will achieve intakes of 2.1-2.2 per cent of BW for a high concentrate feeding period of 170-180 days but this will decline over time to 1.8-1.9 per cent of BW, with slaughter weights of 500 -600kg.

Table 2. Example dry matter intakes on high concentrate feeding systems of dairy bulls

Batch	Initial weight kg	Final weight kg	Intake kg DM	Intake as % of BW
1	110	289	5.59	2.8%
2	110	442	6.07	2.2%
3	320	448	8.06	2.1%
4	300	550	9.35	2.2%

Feed Efficiency

The feed conversion efficiency achieved on high concentrate diets with dairy bulls across six experiments is presented in Table 3. The average feed conversion efficiency was 5 kg DM feed per kg liveweight gain for animals with an initial weight of 98 – 230 kg and a final weight of 448-454 kg. Similar studies have recorded feed efficiency of 9.0 kg DMI per kg carcass gain for similar animals.

Table 3. Examples of feed conversion efficiency on high concentrate feeding systems of dairy cows

Exp. No.	Initial Weight (kg)	Final Weight (kg)	Live weight gain (kg/day)	Total dry matter intake (kg/day)	Feed Conversion Efficiency (kg DMI / kg live weight gain)
1	99	448	1.25	5.8	4.7
2	98	416	1.18	5.5	4.7
3	125	442	1.27	6.9	5.4
4	114	447	1.25	6.5	5.2
5	110	448	1.22	6.3	5.2
6	233	454	1.24	5.9	4.8

Considerable work has been done at Teagasc Grange comparing dairy bulls slaughtered at different slaughter weights. Animals were fed high concentrate diets for six months (179 days) or nine months (272 days). Daily gain over the first six months was 1.4 kg / day. This fell to 1.2 kg / day for the period from six months to nine months. Slaughter weight was 550 kg after six months and 670 kg after nine months. Total concentrate consumption was 1.76 t for six months and 3.0 t for nine months. Feed conversion efficiency was 7.2 and 8.1 kg DMI / kg LWG for the bulls slaughtered at six and nine months, respectively.

Diet Specification

Energy, protein, fibre and minerals are the primary components of the diet that need to be balanced correctly.

Energy

High energy feeds should be fed for maximum weight gains. Dietary energy density will depend on concentrate cost, the response in carcass gain from increasing / decreasing energy density and the corresponding value of carcass gain. The minimum energy density in the concentrate mix should be 0.95 UFV / kg as fed or 1.09 UFV / kg DM. Grange studies, with young bulls slaughtered at 12 months, showed that when a low energy concentrate feed was used, compared to a high energy feed, carcass weights were up to 28 kg lighter on the low energy feed.

The selection of feed ingredients for this system is critical. The primary energy sources are based on starch or digestible fibre. Cereals such as barley, wheat and maize grain are based on starch, while citrus pulp, beet pulp and soya hulls are based on digestible fibre. A mixture of these energy sources is preferable to stimulate intake and reduce the risk of digestive upsets such as acidosis. See sample concentrate mixes below (Table 4).

Table 4. Sample concentrate mixes

Mix	UFV	CP%	PDI
40% barley : 35% distillers grains : 25% citrus pulp + minerals	0.98	14.7	99
40% barley : 25% citrus pulp : 20% maize grain : 15% soyabean meal + minerals	0.96	14.4	100
30% maize distillers : 30% citrus pulp : 36% barley : 4% molasses + minerals	0.94	13.3	90
25% barley : 25% distillers grains : 25% citrus pulp : 25% maize meal +minerals	0.99	12.8	88

The mix being used at Johnstown Castle and the nutritional value (on a fresh weight basis) is presented below.

80% barley	Energy	0.96 UFV
14% soyabean meal	Crude protein	14.7%
3.5% molasses	PDI	100 g
2.5% minerals	Starch	41%

One source of energy e.g. cereal may be used in the high concentrate system, provided it is correctly balanced for protein, minerals and long fibre. It is imperative that feeding management is excellent. This system is inherently more difficult to manage and there is a greater risk of digestive upsets.

Protein

During the growing phase bulls need adequate protein to build a frame and to ensure that they do not remain small and fat. Finishing animals will have a lower requirement for protein because their frame is already established and high levels of protein are not required to lay down lean & fat tissue. Protein may be more critical with Holstein dairy animals that tend to continue to grow rather than lay down tissue. The crude protein content of the concentrate will depend on the composition of the diet, for example where sugar beet, fodder beet or other low protein feeds are being offered a higher crude protein in the concentrate will be necessary.

Table 5. Dietary protein requirements for bulls

Category	Crude protein % / kg diet DM
Bulls (growing)	14-16
Bulls (finishing)	12-13

Roughage Source

Roughage is required for the satisfactory functioning of the digestive system. At least 10 per cent of the DM intake must be a source of long roughage but this should not exceed 15 per cent. This may be silage, straw or hay. Anecdotal evidence would suggest that straw / hay is the preferred option. If feeding hay it is important to ensure intake is not excessive as this will affect performance, but otherwise it is a safe feed. Roughage may be fed separate or mixed with the concentrate. If feeding separately, it is important to ensure animals have adequate access to the roughage and it is regularly freshened up.

Minerals

Cattle need minerals to maintain good health. This is particularly important on a high concentrate feeding system where issues such as hoof health may be compromised if animals are on a high concentrate diet for long periods of time. It is important that a standard beef ration is not used for *ad libitum* feeding as the mineral specification will be in excess of requirements and may lead to poor performance and the risk of toxicity and severe diarrhea.

Grain Processing

Ground cereals should not be used in high concentrate feeding systems. Pelleted rations are generally manufactured with ground cereals – check with the manufacturer.

Water

Water intake will be high on this system. Animals on *ad libitum* concentrate have a high rate of metabolism and dissipate a lot of sweat. Fresh water must be available at all times. It is recommended that water troughs be inspected daily and cleaned at least 2-3 times a week or immediately if water is fouled. Animals must never be left without water on this system. Inadequate water intake will depress feed intake and consequently performance.

Feeding Management

Feeding management is critical. There are a few basic rules that must be adhered to:

Introducing the concentrate

An introductory period of approximately 3 weeks is necessary to allow animals adapt to a concentrate based diet. Start off on 3 kg concentrates and every 4 days add 1.5 kg concentrates. Animals should have full access to silage / roughage while being built up to high concentrate diets. A suggested program for introducing cattle to a concentrate based diet is presented in Table 6.

Table 6. Routine for introducing *ad-libitum* concentrate

	kg concentrate/ day	*Roughage available*	*Feeding routine*
Day 1	3	Ad lib	Feed once / day
Day 5	4.5	Ad lib	Feed twice / day
Day 9	6.0	Ad lib	Feed three times / day
Day 13	7.5	Ad lib	Feed three times / day
Day 17	9.0	Ad lib	Feed three times / day
Day 21	10.5	Ad lib	Feed three times / day
Day 24	*Ad-libitum*	10% of DM intake	Feed ad lib

By gradually introducing cattle to a high concentrate diet, the risk of acidosis or feed sickness is reduced. At any sign of excessive scouring or digestive upset, decrease the concentrate level to the previous step for a few days. Animals should be watched closely and regularly during the introductory period. A culling policy should be put in place whereby problem animals are removed. These animals will most likely not perform throughout the finishing period, incur large costs and therefore result in reduced returns.

Frequency of feeding

Subsequent to the introductory period once daily feeding should be satisfactory after the introductory period, if troughs are large enough. It is not safe to ever go below 5 per cent remaining in the trough. Do not have cattle waiting on empty troughs for the next feed.

Feed trough management

Good feed trough management is essential in preventing digestive upsets. It is essential to recognize that even slight digestive upsets will affect growth rates and therefore your profitability long before an animal is recognisably sick. Bird / vermin infestation can be a problem where animals are being fed high levels of concentrates. Methods to overcome this include the use of shorter troughs or preferably hoppers.

Housing

Providing less than recommended space will cause stress in animals, depress feed intake and consequently reduced animal performance. In general, slatted pens are not ideal for high concentrate feeding for long periods of time. Straw bedding or out-wintering pads are preferable options.

It is critical that the housing is thoroughly checked out before housing animals. The principles of good ventilation must be followed. These include adequate pitch of the roof (15^{o}), as well as adequate inlets and outlets and space sheeting on the roof. The importance of air movement cannot be over-emphasised.

Animals on high concentrate feeding systems dissipate a lot of sweat to keep themselves cool. Signs of animals sweating excessively translates into lack of air movement in the house. This is energy wasted that could otherwise be used for liveweight gain. Feed intake and performance will suffer severely unless this is dealt with.

New Dairy Calf to Beef Research at Johnstown Castle

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Summary

- A new trial was established in April 2010 at Johnstown Castle with the objective of investigating the performance and economic profitability of spring born dairy bull calves.
- Breed types include Holstein-Friesian, Jersey × Holstein-Friesian and a limited number of three way crossbred animals (Norwegian Red bull × Jersey crossbred cow).
- Sixty calves were housed and put on *ad-libitum* concentrates, 120 calves were given 2 kg of meal at grass and 120 calves were on grass only.
- The concentrate mix was 80 per cent barley, 14 per cent soya, 4 per cent molasses and 2 per cent minerals. The same concentrate mix was given to the calves indoors and the concentrate group of calves at grass.
- Grass budgeting is carried out weekly on the farm. Due to the limited number of animals involved in the study grass demand was low. Surplus grass was removed as baled silage and the less productive paddocks were reseeded.
- Liveweight and average daily gain were highest with the *ad-libitum* calves, lowest with the grass only calves and intermediate for calves on concentrate at grass.
- Ninety calves (30 *ad-libitum*, 30 grass + 2kg of meal and 30 grass only calves) were slaughtered at less than eight months of age. Significant differences were apparent between the three production systems.

Introduction

In April 2010, a dairy calf to beef trial was established in Johnstown Castle for the purposes of research demonstration to Irish dairy beef producers. The objective is to investigate the production performance and economic profitability of dairy bull calves across a range of finishing systems.

The breed types included in the study represent male progeny from both current and projected future breeding policies of Irish dairy producers. The Holstein-Friesian (HF) is the dominant breed in the Irish dairy cow population. Also, due to performance results of the Jersey × Holstein-Friesian (JEX) cows from New Zealand and the "Ballydague" Research farm, Moorepark, (improvements in reproductive performance, increased milk solids yield per hectare, longevity and improved profitability) some dairy farmers are going down the route of Jersey crossbreeding. As a result the proportion of JEX bull calves is expected to rise. The research demonstration farm sourced 300 spring born dairy bull calves from herds in the South of the country; 165 Holstein-Friesian (55 per cent) and 108 Jersey × Holstein-Friesian (36 per cent) and 27 three-way crossbred animals (9 per cent; Norwegian Red bull × Jersey crossbred cow). Animals arrived on site in late April/early May (10-12 weeks of age). All calves were weaned at the time of purchase. Calves were randomly assigned to one of ten systems according to breed type, date of birth, body weight on arrival to Johnstown Castle and farm origin.

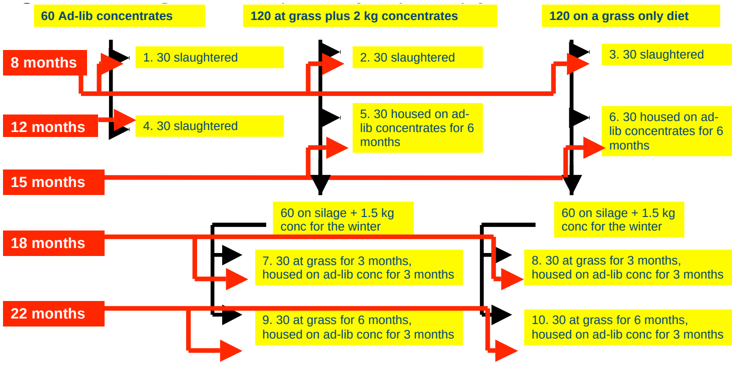
Finishing Systems

Three groups (90 calves in total) were finished at less than eight months: 30 calves on *ad-libitum* concentrates indoors (AL), 30 calves at pasture plus 2 kg concentrate (PC) and 30 calves on pasture only (PO) (groups 1, 2 and 3; Figure 1). The concentrate mix used was 80 per cent barley, 14 per cent soya, four per cent molasses and two per cent minerals. *Ad-libitum* calves were housed three weeks after arrival at Johnstown and the remaining 240 calves were put out to grass. Throughout the grazing season PC calves were given their 2 kg allocation of concentrate with the remaining 120 calves staying on grass only. In doing so, the effect of lifetime performance of concentrate supplementation in the first summer for calves at pasture can also be investigated. The remaining 30 animals on AL will be slaughtered at <12 months (Group 4) of age. In total, 120 animals will be slaughtered at less than 12 months of age.

The remaining 180 bulls will be slaughtered under three different systems; 15, 18 and 22 months of age. Thirty bulls from each system (PC and PO) will be housed at the end of the grazing season and built up onto an *ad-libitum* diet for six months (groups 5 and 6; Figure 1).

In spring 2011, 120 bulls will be turned out to pasture (60 calves from the PC group and 60 PO calves). These will have been carried over the winter on an *ad-libitum* silage diet plus 1.5 kg concentrate. After three months at pasture, 30 bulls from each group (groups 7 & 8; Figure 1) will be housed and built up onto an *ad-libitum* concentrate diet for three months. The remaining 60 bulls (groups nine and 10) will remain at pasture until September before being housed on an *ad-libitum* concentrate diet for three months. This group will be slaughtered at 22 months of age.

Figure 1: Finishing treatments of the dairy calf to beef system at Johnstown Castle.



Pasture Management

Maximising the proportion of good quality pasture is of utmost importance for grass production systems. The calves involved in the trial (120 grass only calves and 120 calves at pasture plus 2 kg concentrate) were the sole stock available on the land area. Therefore, this year pasture management was somewhat artificial in that no adult animals were on the grazing platform and grass demand was low. The two groups at grass were further subdivided into groups of sixty. This ensured that the smaller calves on concentrates received their 2 kg allocation. Grass budgeting was carried out weekly and target pre-grazing herbage yields were established. Pre-grazing herbage yields averaged 917 kg DM/ha (8.4cm) for the summer months (May – July). Pre-grazing herbage yields that exceeded 1400 kg DM/ha were not grazed and subsequently removed from the rotation as baled silage. Pre-grazing herbage yields increased in the autumn. Average pre-grazing herbage yields for this period was 1150 kg DM/ha. Throughout the grazing season fresh pasture was allocated to the calves every 2-3 days. Post grazing heights for the swards averaged 4.8 cm.

A reseeding programme was also set in place. Twelve hectares of the lower yielding paddocks were reseeded this year: five hectares in April and seven hectares in August. The grass seed mixture used in the spring consisted of 44 per cent Tyrella, 44 per cent Abermagic and 12 per cent clover (Crusader). With the exception of Astonenergy replacing Abermagic the grass seed mixture used in the autumn was the same.

Animal Performance

Liveweight and average daily gain (ADG) of the three feed systems are presented in Table 1. On October 21st calves on PO were 56 kg lighter than PC and 120 kg lighter than AL. Average daily gain was highest with the AL, lowest with the PO and PC intermediate. Group intakes were measured for the AL calves throughout the year. For breed comparison purposes the HF and JEX were penned in separate groups. Estimates of total individual intake for the HF and JEX calves indoors to date are 808 kg DM and 724 kg DM, respectively.

Table 1. Production performance of dairy bull calves on three feeding systems on Oct 21st

Treatments	Ad-lib		Pasture + 2 kg		Pasture	
No. of calves in group	31		88		83	
Live weight (kg)	292		228		172	
ADG (kg/d)	1.26		0.86		0.52	
Breed Groups	HF	JEX	HF	JEX	HF	JEX
Live weight (kg)	306	269	233	221	174	171
ADG (kg/d)	1.33	1.16	0.89	0.83	0.54	0.52

**ADG = Average daily gain*

<8 month slaughter

Liveweight, ADG and slaughter data for the three systems are presented in Table 2. Liveweight and average daily gains were highest with the AL, intermediate with the PC and lowest with the PO. Consequently, carcass weight followed a similar trend. Kill out was 474 g/kg, 460 g/kg and 410 g/kg for the AL, PC and PO, respectively. Comparative production and slaughter performance between the HF and JEX is also presented. While differences between the three systems and breed groups are evident, it must be stressed that care should be taken in interpreting these results due to the limited number of animals in the study. Further research is warranted to see if these results hold true.

Table 2. Treatment and breed effect on the performance of dairy bull calves slaughtered at less than 8 months

Treatments	Ad-lib		Pasture + 2 kg		Pasture	
Live weight (kg):						
Start	85		85		85	
Slaughter	264		206		149	
ADG (kg/d)	1.19		0.83		0.45	
Carcass weight (kg)	126		96		61	
Kill out (g/kg)	474		460		410	
Breed Groups	HF	JEX	HF	JEX	HF	JEX
Live weight (kg)	275	252	223	195	164	143
ADG (kg/d)	1.25	1.12	0.86	0.77	0.48	0.43
Carcass weight (kg)	133	119	107	87	68	57
Kill out (g/kg)	481	469	476	446	418	403

Animal Health

The importance of having a healthy calf to begin with cannot be overemphasised. On arrival all calves were tested for bovine viral diarrhoea (BVD) and vaccinated for infectious bovine rhinotracheitis (IBR), using an intranasal vaccine and also for Black leg. Numerous incidences of respiratory diseases were encountered throughout the experimental period. Isolated incidences of pink eye occurred in the late summer/autumn. All animals were treated for internal and external parasites. Calf mortality for the year was five per cent. Such losses were largely attributed to respiratory problems.

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Labour efficient calf rearing

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'A building is only as good as its foundation'

This quote is also true in relation to calf rearing. All systems of dairy and beef production are dependent on the generation of quality young stock. If the initial foundation stones are not properly laid there will be negative repercussions for system viability and profitability.

The Irish dairy industry is currently poised for expansion in the post-quota era. Given the explosion in the number of calves being generated within dairy herds over the past year or so there is tremendous potential for beef farmers to diversify into dairy calf-to-beef systems. However, calves need to be given the best start possible in order to ensure that the rearing process is as easy and labour efficient as possible. There are a few key areas that need to be given thorough consideration when rearing calves. These include i) housing, ii) milk feeding, iii) weaning and iv) health.

When the calf is born

When the calf is born there are two key things to remember i) iodine for the navel and ii) colostrum.

When applying iodine to the calf's navel use tincture of iodine – it contains alcohol, which will help dry the cord and discourage pathogen movement up the cord, reducing the risk of navel-ill and joint-ill. Do not be tempted to use an iodine-based teat dip as it contains emollients which are intended to keep teats soft and pliable and thus will not perform the important function of drying the umbilical cord.

Colostrum (biestings) is the cow's first milk after calving and is present for up to three days. At birth a calf's immune system is not fully developed, and colostrum imparts passive immunity from the dam to the newborn calf via intestinal absorption of antibodies from the milk. Generally a calf should receive 5 - 6 per cent of its body weight (typically two litres) as colostrum within the first six hours of life, and another 5 - 6 per cent of its body weight at eight hours of age. As time from birth increases, the ability of the calf to absorb the antibodies in the milk is reduced. Therefore, it is critical to feed colostrum as soon as possible after birth in order to ensure maximum long-term immunity is acquired. Colostrum feeding should continue for three days after birth. The ideal source of colostrum is the calf's own dam for two main reasons i) it minimises the potential spread of Johnes disease and ii) the calf will acquire immunity to fight pathogenic organisms encountered on the home farm.

Housing

If dairy calf-to-beef systems are to be viable in the future, and greater numbers of stock need to be catered for, farmers may have to explore the possibility of rearing the pre-weaned calf outdoors rather than building more conventional housing. Over the past number of years Teagasc, Moorepark has been investigating different types of housing for the pre-weaned calf. The first component of the project was to determine if calves could be turned out at an early age (2 – 3 weeks old) without compromising weight gain and vitality when compared to calves reared indoors. Results from the first year of the study indicate that there is no difference in weaning weight between the indoor and outdoor rearing systems (Table 1). However, it is deemed necessary to provide shelter for all calves outdoors.

Table 1. Preliminary results of heifer calves reared indoors and outdoors for nine weeks pre-weaning

	Indoor Rearing	Outdoor Rearing
Weaning weight (kg)	69	71
Weaning shoulder height (cm)	83	84
Weaning heart girth (cm)	97	99

The next phase of the project investigated if shelter type impacted on calf health, welfare and weight gain. The three housing systems that were compared were i) indoors, ii) outdoors with low cost roofed shelters (Figure 1a) and iii) outdoors with straw bale shelters (Figure 1b). Calves were weaned once they had achieved the required weight which depended on breed (e.g. HF > 85 kg; JEX > 75 kg). There was no difference between treatments in the number of days from birth to weaning (78 days). However, there was a higher disease incidence in the calves reared indoors, followed by those from the straw treatment, with the calves provided with roofed shelters being the healthiest. Calf weight gain was monitored throughout the subsequent summer months. Interestingly, calves from the roofed shelter treatment continued to have higher weight gains, followed by calves from the straw treatment, with those that were reared indoors being significantly lighter than the two outdoor reared groups. It was concluded from this study that if calves are to be reared outdoors they should be provided with roofed shelters.

Figure 1. a) Low cost roofed shelter – with ventilation holes and a raised wooden floor b) Straw bale shelter – used as a wind breaker for calves

Milk Feeding

Approximately seven per cent of the labour input per day on a dairy farm is associated with calf care over a 12-month period. However, the peak labour requirement for calf care occurs during a 12-week period when calves are being offered a milk-based diet. An ideal scenario would be to minimise the labour input required during this time, without compromising calf health and welfare. A study investigating the labour input associated with calf care on Irish dairy farms was recently carried out by Teagasc, Moorepark. This study found that practices such as grouping calves and feeding milk once per day will reduce labour. From Table 2 it is evident that once per day milk feeding requires the least labour input (23 sec/calf/day). In addition, calf weight at 77 days is not adversely affected.

Table 2. Effect of calf feeding system on daily labour input, calf weight and weight gain

	Automatic Feeder	*Once daily with teats*	*Twice daily with teats*	*Twice daily with trough*
Total calf care time incl. vet. time (sec/calf/day)	38	23	36	27
Calf weight at 77 days (kg)	95.0	94.8	93.2	90.5
Calf weight gain per day (kg)	0.70	0.79	0.80	0.65

Weaning

As milk feeding is one of the more labour intensive tasks associated with rearing calves, there may be a temptation to wean calves at an early age. Calves are generally weaned by either age or weight. In a recent experiment at Teagasc Moorepark calves were weaned at either 8, 10 or 12 weeks of age. An equal number of Holstein Friesian and Jersey x Holstein Friesian calves were assigned to each of the three treatments. The preliminary results in Table 3 illustrate that calves weaned at eight weeks old were still very small at weaning, having only gained 26 kg from birth to weaning. Calves weaned at a later age (i.e. higher weight) gained 44 kg from birth to weaning. Although these calves consumed an extra 126 litres (28 gallons) of milk compared to the calves weaned at 8 weeks it ensured healthier calves with greater vitality. This was indicated by a lower incidence of disease in the older compared to the younger weaned calves.

Table 3. Effect of weaning age on weight and weight gain

	8 weeks	10 weeks	12 weeks
Weaning weight (kg)	58	69	77
Weight gain from birth to weaning (kg)	26	36	44
Weight 21 Jul (kg) (153 days old)	120	126	128

Health

Of course with any calf rearing system hygiene and the minimisation of disease are critical in ensuring a healthy herd. One of the big issues to be mindful of with young calves is scour. Scour, or diarrhoea, is one of the most common conditions seen in young calves, particularly in the first month of life. Many infectious agents such as rotavirus, coronavirus, *E. Coli spp*. and *Cryptosporidium spp.* can cause scour, as can nutritional factors. When calves have scour the capability of the intestine to absorb water is impaired which results in the loss of large amounts of fluid. Consequently the calf quickly dehydrates, electrolytes become unbalanced and energy reserves are depleted. The treatment of scour in calves involves replacing lost body fluids, correcting the electrolyte imbalance, and supplying energy. Ideally prevention is better than cure – the following guidelines should be followed in order to help prevent the occurrence of calf scour:

- Ensure calves get adequate colostrum within six hours of birth
- House calves in a draught-free well-ventilated environment. If reared outdoors, calves should be provided with adequate shelter from prevailing wind and rain
- Disinfect calf house regularly (at the least between every batch) and ensure all feeding equipment is thoroughly cleaned after each use
- Provide adequate nutrition, especially during cold weather, and make sure there are no abrupt diet changes
- Quickly identify any calves that develop scour and isolate them from the rest of the group. Clean up any contamination
- If buying in calves, quarantine them for at least seven days before mixing with other calves.

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