Efficient, Sustainable Beef Production using Dairy-bred Animals

A report for

NUFFIELD IRELAND

Farming Scholarships

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Executive Summary

This report investigates the potential to add greater value to calves from the dairy herd to produce quality prime beef. Driven by the recent abolition of EU milk quotas, the Irish dairy herd has grown by more than 200,000 head to over 1.4 million cows over the three year period to June 2016. Notwithstanding recent market volatility, further growth is anticipated over the coming years. Many Irish dairy farms that previously reared their surplus calves are likely to sell them. These supply developments present opportunities for Irish beef farmers and the wider industry.

The key objectives of this report are:

1. To examine the production systems used to produce beef from dairy-bred animals in Ireland and other major producing countries
2. To analyse current market outlets for Irish beef and livestock, their requirements and how these are likely to evolve in the future
3. To investigate further the relationship between efficiency and environmental sustainability in dairy calf to beef production systems

Key Findings:

Dairy-bred animals produce lighter carcases, with less developed conformation than their suckler counterparts. However, well-managed dairy-beef systems have the potential to sustainably produce consistent quality beef, as well as positive margins at farm level.

In each of the countries visited during this study, the leading beef producers had identified their competitive advantage and were making optimum use of the resources on-farm. The Irish beef sector would benefit from the adoption of certain aspects of both intensive and extensive systems, including regular performance monitoring (weighing), professional feeding management and greater awareness of production costs per kilogramme of output. Several integrated supply chains exist for dairy-beef, which substantially reduce the producer's financial risk. Successful technologies were also observed in meat plants, which resulted in improved carcase yield and reduced processing costs.

The UK and continental EU markets look set to remain the primary destinations for Irish beef exports. However, volumes to the US, Asia and the MENA region are likely to grow

substantially from their current levels. Producers need to have a good understanding of market requirements and should receive consistent signals in this regard from meat plants. Dairy-beef crosses tend to be more valuable than pure dairy animals, on account of superior performance, grading profile and available price bonuses. Beef-cross calves can therefore represent a useful revenue stream for dairy farmers.

In the context of global population growth and the resulting challenge to sustainably increase food production, it is notable that dairy-beef tends to produce significantly fewer greenhouse gas emissions, or lower carbon footprint, than suckler beef. There is potential at farm level to considerably improve the average carbon footprint of beef production. In most cases, the adoption of such mitigations also raises efficiency and reduces production costs.

Recommendations:

1. Teagasc should establish a dedicated research centre focusing on all aspects of dairy calf to beef production.
2. The completion of a Dairy-beef Index (DBI) by Teagasc and ICBF will allow dairy producers to more reliably select beef sires for calving ease, short gestation and calf quality.
3. Teagasc, ICBF and industry stakeholders should consider possibilities for further research in the area of sexed semen technologies.
4. The Irish beef industry could benefit from adopting certain aspects of the integrated supply chains which operate internationally for dairy-bred animals.
5. The development and promotion of premium beef schemes, which return price bonuses to producers, should continue to be supported by Bord Bia and others.
6. Teagasc and Bord Bia need to better engage with farmers with regard to sustainability, through discussion groups and uptake of the Carbon Navigator.
7. A control programme needs to be developed and implemented for IBR (infectious bovine rhinotracheitis) by the Department of Agriculture, in conjunction with Animal Health Ireland, to protect Ireland's live export sector.
8. All operators within the livestock sector must be conscious of their "social licence to operate", the importance of which is highlighted by some high-profile animal welfare related incidents internationally in recent years.

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Foreword

I come from a beef farm in Co. Limerick where I was fortunate to become immersed in all aspects of the family business from a young age. This early experience nurtured a passion for all things cattle-related, including rearing calves, buying and selling animals, nutrition, animal health, grassland management and financial planning. I graduated from UCD in 2002 with a first-class honours degree in Agricultural Science. I subsequently completed a management training programme in the meat processing industry, and later became a nutrition advisor to beef and dairy farmers. Since 2007, I have been working for Bord Bia, the Irish Food Board, as Sector Manager for Beef and Livestock. The role is a varied and interesting one, and combines promoting Irish exports to overseas buyers and communicating with producers on market developments, our programmes and plans. I also farm part-time on my own holding and remain closely involved in the home farm.

During recent years I met several Nuffield scholars looking for insight into the Irish beef industry and markets. They invariably portrayed Nuffield in a positive light, as a unique opportunity to open up a vast network of international contacts. I applied for a scholarship myself, and was delighted to receive a phone call a few weeks after the final interview to learn that I had been selected. I decided to focus on beef production from the dairy herd. With the abolition of EU milk quotas in April 2015, Irish dairy farmers were given their first real chance to expand production in more than three decades. Notwithstanding recent market volatility, milk producers have increased cow numbers significantly and further growth is anticipated over the coming years. While all parts of Ireland have experienced this expansion, my home province of Munster is the dominant one with regard to dairying. Its six counties collectively account for more than 60% of the national dairy herd, according to the DAFM's AIM system. In this region, dairy cows already outnumber sucklers by 2.5 to one.

I was keen to investigate the likely impacts and opportunities that developments in dairy would present for the Irish beef sector. I wanted to visit countries producing significant numbers of dairy-bred cattle and to identify systems of production which were economically and environmentally sustainable, while meeting the requirements of their particular market. Receiving a Nuffield scholarship has been an amazing journey. It allowed me to extensively

research my study topic, while broadening my knowledge of global agriculture through the wide network of scholars and other industry leaders I have met.

The first major activity of my Nuffield programme was attending the annual Contemporary Scholars' Conference which took place in Reims, France in March 2015. All 75 of the year's scholarship recipients met together for one week. We discussed issues of key importance to all of our industries, including leadership, communication, knowledge extension and sustainability.

After the CSC, I took part in the Global Focus Programme, which is a six-week tour of global agriculture organised by Nuffield Australia. The journey incorporated the UK, California and Washington in the US, Mexico, Brazil and New Zealand. This was a truly amazing experience, visiting numerous impressive agri-related businesses and organisations. There were nine other scholars in my GFP group, including six Australians, one Kiwi, one Canadian and another Irishman. A diversity of farming sectors was also represented: beef, sheep, dairy, arable and horticulture production. This greatly enhanced the quality of our meetings and discussions, with some really insightful observations. Travelling away from home and work for this extended period presents its challenges, but it makes you focus on the "bigger picture". You begin to worry less about the day to day issues and concentrate instead on possible changes that could be made to improve your industry or business.

While undertaking this study, I visited numerous beef producing countries, including the UK, the Netherlands, France, Spain, Italy, Germany, Portugal and Russia. I met with many outstanding producers and other industry-leaders who had developed successful strategies for dairy-beef. Almost two thirds of the EU breeding herd is made up of dairy cows, as opposed to sucklers. Across Europe, prime beef production is predominantly based on intensive, indoor feeding strategies. While continental European producers tend to have access to low cost concentrate feeds and achieve higher daily liveweight gains, Ireland has a major competitive advantage in being able to grow and utilise a large quantity of grass.

To conclude my travels I spent three weeks in New Zealand and Australia. I was keen to learn about innovations there in production, processing and marketing, and to understand how their industries have addressed certain animal welfare controversies that had received negative publicity in recent years.

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First of all I would like to thank my wife Tish for her constant encouragement and support over the past two years. I am very grateful to my family and especially my father for his patience and endeavour while I've been away.

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- Michael Sheahan, Senior Superintendent Veterinary Inspector, DAFM
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- Pat Dillon, Teagasc Moorepark
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- Rory Fanning, Slaney Foods Group

- Ed Green, Winterwell Farm, Somerset, UK
- Gary Allis, Furze Hill Farm, Bilsby, Lincolnshire, UK
- Johnny Alvis, Lye Cross Dairy, Somerset, UK
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Finally, I thank my reviewers for their guidance in writing this report.

Abbreviations

AHI	Animal Health Ireland
AIM	Animal Identification and Movements (National Traceability System)
BDGP	Beef Data and Genomics Programme
BSE	Bovine Spongiform Encephalopathy
CO2-eq	Carbon Dioxide Equivalent (measure of carbon footprint)
CSC	Contemporary Scholars' Conference
CWE	Carcase Weight Equivalent
DAFM	Department of Agriculture, Food and the Marine
EU	European Union
EEC	European Economic Community
EID	Electronic Identification
FCE	Feed Conversion Efficiency
FOB	Free On Board
GFP	Global Focus Programme
IBR	Infectious Bovine Rhinotracheitis
ICBF	Irish Cattle Breeding Federation
MLA	Meat and Livestock Australia
KPI	Key Performance Indicator
PW	Product Weight
QPS	Quality Payment System
RVO	Rijksdienst voor Ondernemend (Netherlands Enterprise Agency)
STEC	Shiga Toxin-Producing *Escherichia coli*
TB	Tuberculosis
UCD	University College Dublin
UFV	Unité Fourragère Viande (measure of energy in feed)
VIA	Video Image Analysis
VL	Visual Lean (usually expressed as %)

Objectives

In the context of the significant expansion presently taking place within the Irish dairy herd, the objectives of this study were to investigate the likely impacts and opportunities for the Irish beef sector as follows:

- To examine the production systems used to produce beef from dairy-bred animals in Ireland and other major producing countries.
- To analyse current market outlets for Irish beef and livestock, their requirements and how these are likely to evolve in the future.
- To investigate further the relationship between efficiency and environmental sustainability in dairy calf to beef production systems

Introduction

Agriculture and food represent Ireland's largest indigenous industry. In 2015, the value of Irish agri-food and drink exports reached a record level of €10.8 billion. Beef and dairy are the two most important primary production sectors, accounting for exports of €2.41 bn and €3.24 bn, respectively (Bord Bia, 2016). Their dominance reflects the grass-based nature of Irish farming. Ireland has a total agricultural area of 4.5 million hectares, of which 81% is devoted to pasture, hay and grass silage, while a further 11% is classified as rough grazing. The remaining 8% relates to crops, fruit & horticulture production (DAFM, 2016).

The beef and livestock sector plays a key role in the Irish rural economy. There are over 100,000 farms involved in cattle production, whose activity supports major employment outside of primary production including beef processing, agricultural contractors, merchants and livestock marts. From a supply base of approximately 1.05 million beef suckler cows and 1.4 million dairy cows (AIM, June 2016), the sector produces over 550,000 tonnes of beef annually, of which almost 90% is exported. As a result, Ireland is the largest net exporter of beef in the northern hemisphere and the 5th largest in the world. In recent years, over 95% of Irish beef exports have been focused on the higher value consumer markets of the UK and continental Europe. Irish beef is supplied to over 85 EU supermarket chains, as well as major manufacturing and foodservice customers.

Irish cattle farming is characterised by a wide diversity of production systems. Some of this variation is associated with the geographic regions and their prevailing soil types. Suckler production is most prevalent in the western counties, whereas dairy-bred cattle predominate in the south of the country. Only a small percentage of animals are carried through to beef on the farm of origin. There is a long history of trading animals at different stages of their lives, going back to the cattle fairs, which were gradually replaced by the livestock marts in the 1950's and 60's. Even today, Irish beef cattle still change hands twice, on average, between different farms during their lifetime (AIM, 2016). The frequent division between the roles of the breeder, store producer and finisher reflects the relatively small scale of many farms, and their preference to specialise in just one stage of the supply chain.

In Ireland, CAP support payments introduced in the early 1990's were successful in growing the national suckler herd to exceed the dairy herd. In recent years, suckler cow numbers

have been stable at approximately 1.05 million head, although this figure is 150,000 below its 2008 level. This important source of beef-bred animals enhances Ireland's reputation as an exporter of high quality beef. Suckler-bred animals tend to achieve a heavier weight for age and superior grading profile than cattle coming from the dairy herd. As a result, they usually receive higher prices per kilo through the Quality Payment System. The QPS was introduced to reward carcases with better-developed conformation, which generally produce a higher yield of saleable meat.

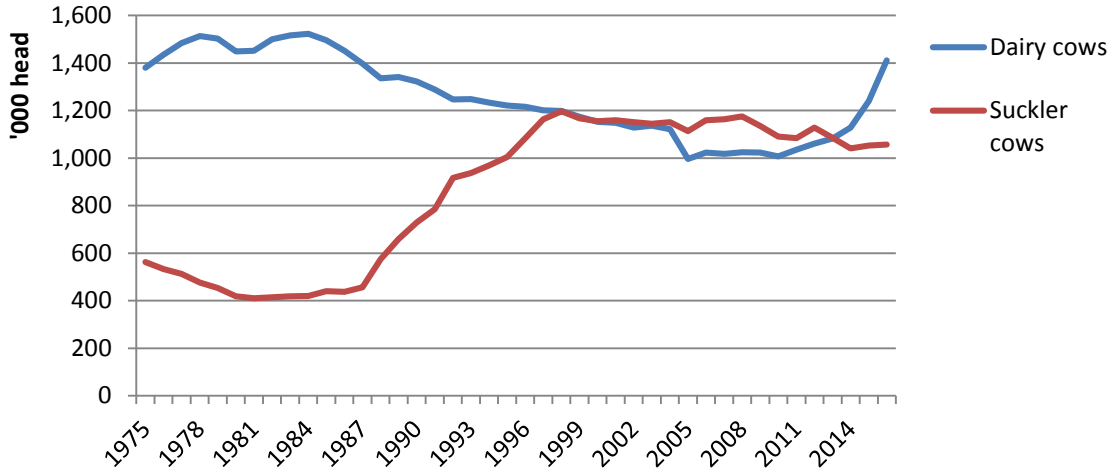

Figure 1: Irish Dairy vs. Suckler cow numbers 1975 – 2016 (DAFM & CSO, 2016)

It is important to realise that the dairy herd is already a significant source of quality prime beef for the processing sector. Across Europe, almost two thirds of the animals raised for beef or veal originate from dairy, as opposed to suckler herds (EU Commission Beef Working Group, 2016). With the abolition of EU milk quotas in April 2015, Irish dairy farmers were given their first real chance to expand production in more than three decades. Notwithstanding recent market volatility, the national dairy herd increased by more than 200,000 head to over 1.4 million cows over the three year period to June 2016. Further growth is anticipated over the coming years. Many Irish dairy farms that previously reared their surplus calves are likely to sell them. These supply developments present opportunities for Irish beef farmers and the wider industry, which will be considered within this report under the following main headings:

- Developing the "right" system
- Producing for the market
- The live export route
- Sustainability

1. Developing the "right" System

Dairy expansion is naturally creating an increased supply of calves. Historically many Irish dairy farmers retained their male dairy calves and beef-crosses for rearing. However, with increased specialisation more calves are being presented on the market at a young age. As a result, there is a growing opportunity for livestock farms to focus on the successful rearing of calves, whether the intention is to finish them or sell as store animals.

Experienced calf buyers emphasise the importance of good selection. Calves which are a minimum of two weeks of age and over 50kg in weight are preferred to younger, lighter calves. Judging the likely potential of a calf is a different "art" to that of buying store cattle, but the principal focus should be to select animals which are healthy and alert, with a clean, shiny coat. Calves which show signs of illness are to be avoided, such as dehydration, nasal discharge, swollen joints or wet navels. Ideally they should have reasonably straight, rather than angular, frames. It is becoming increasingly popular to source calves directly from the farm of origin, particularly where the health and performance are found to be good.

Having acquired a group of healthy young calves, the most important stage of any dairy-beef production system is the rearing period up until weaning. At farm level, there has been a renewed focus in recent times on calf management pre-weaning. There is growing evidence that successful nutrition and husbandry practices employed during a calf's early life can enhance its future productivity, both for finishing and breeding purposes.

Calves are born without the antibodies that provide resistance to disease. Maternal colostrum (biestings) is the traditional source of antibodies, or immunoglobulins (IgG). The young calf is only capable of efficiently absorbing IgG during the first 10 to 12 hours of life. The latest advice from AHI (Colostrum 1-2-3) recommends that calves receive colostrum from the cow's first milking, within two hours of birth and a volume of three litres per typical 35-45kg calf. Used with care, the stomach tube is a very effective method of feeding colostrum.

A large-scale experiment at Teagasc Grange found that 30% of the calves tested had received inadequate antibodies from ingested colostrum. The subsequent incidence of disease and mortality among these calves was significantly higher than calves with adequate immunoglobulin (IgG) levels as shown in table 1 below.

Immunoglobulin status	Low	Adequate
No. of calves	1,530	3,570
Diarrhoea (%)	21	14
Respiratory disease (%)	36	28
Mortality (%)	11	3

Table 1: Effect of calf blood serum immunoglobulin levels on disease incidence (Teagasc Grange, 1986)

The design of calf housing facilities should allow calves to perform to their maximum ability, while minimising the disease risk. Principal considerations include the following:

- Provide calves with a clean, dry lying area.
- Protect from draughts.
- Provide adequate ventilation.
- Enable access for feeding, bedding, monitoring and handling of calves.

Calf nutrition strategies have changed in recent years. A traditional recommendation centred on feeding two litres of milk (or milk replacer) twice daily, and its main goal was to enable the early transition from milk onto dry feed. This practice regularly failed to meet the calves' nutritional requirements; growth targets were rarely achieved and regular disease issues arose. Nowadays, a common guideline is to feed 12 - 15% of calf birthweight daily in terms of milk solids, which equates to approximately 5-6 litres of whole milk or 600-750 grammes of high quality milk replacer. Calves should be fed twice daily up to four weeks of age (in accordance with the EU Calf Welfare Directive 2008/119/EC) after which they can be fed once-a-day. The target for successful calf rearing should be to achieve an average growth rate of 700g per day up to weaning, resulting in 100kg liveweight at 12 weeks.

Research by Teagasc and others has shown that prioritising the nutrition of the calf in the rearing stage not only raises the calf's weaning weight but also its subsequent performance.

Milk replacer offered (kg)	25kg	50kg	Difference (kg)
Wt. at 3 months (kg)	96	105	+9
Wt. at 8 months (kg)	205	218	+13
Wt. at slaughter (25 months)	637	662	+25
Carcase wt. (kg)	346	357	+11

Table 2: Effect of level of milk replacer over a 56-day period on lifetime performance of Holstein-Friesian steers (Harte and Fallon, 1986)

In terms of composition, milk replacer should contain a minimum of 20% protein. The source of protein is equally as important as its content. Dairy proteins are far more digestible for young calves than vegetable-based proteins. Although skim milk powder is regarded as the “Rolls Royce” ingredient, in recent years formulations based on whey powder have been found to perform equally well. The oil level in milk replacer should be between 15 and 20% (Fallon, 1999).

To achieve target growth rates and encourage rumen development, calves should be offered concentrates within the first week of birth, along with access to clean drinking water. Calf starter ration should contain 17-18% crude protein, energy over 0.95 UFV / kg as fed and consist of either pellets or coarse particles. Dusty feeds should be avoided. Timing of weaning should be based on the level of dry feed intake as well as on age and growth rate. Before weaning, calves should be consuming a minimum of 1.0kg of concentrate daily. For a week prior to weaning, milk feeding should be gradually reduced. Some roughage should also be fed pre-weaning such as good quality hay or chopped straw. However, care should be taken not to over-feed roughage at this stage as it dilutes the energy of the diet. Along with slower growth rates, calves are likely to develop a pot belly condition.

The aforementioned rearing principles apply to all of the main dairy calf to beef systems (except for white veal), and targets will be broadly similar for the different breed types, males and females. After weaning, there are numerous different possible approaches to bring animals to finish. The choice of system will depend upon the available resources; which include land area, pasture quality, housing facilities, along with the experience, skill set and time constraints of the individual producer. Feed prices should also be taken into consideration, as should the market signals from meat plants or exporters (which will be discussed in chapter 2).

To develop a successful strategy for dairy beef production, it is essential to consider:

- Influence of genetics
- Alternative systems available.

1.1 Influence of Genetics

In Ireland, the supply of dairy calves is highly seasonal, with over 80% born in the first 4 months of the year. During 2015, 60% of the calf registrations to dairy cows and heifers were sired by dairy bulls, with the Holstein-Friesian breed accounting for the vast majority. (This proportion has risen from 50% ten years ago, as dairy farmers are seeking to breed more replacement heifers.) The remaining 40% of calves from dairy dams were sired by beef bulls. Angus and Hereford are the most popular beef breeds for crossing with dairy cows, followed by Limousin (DAFM, 2016).

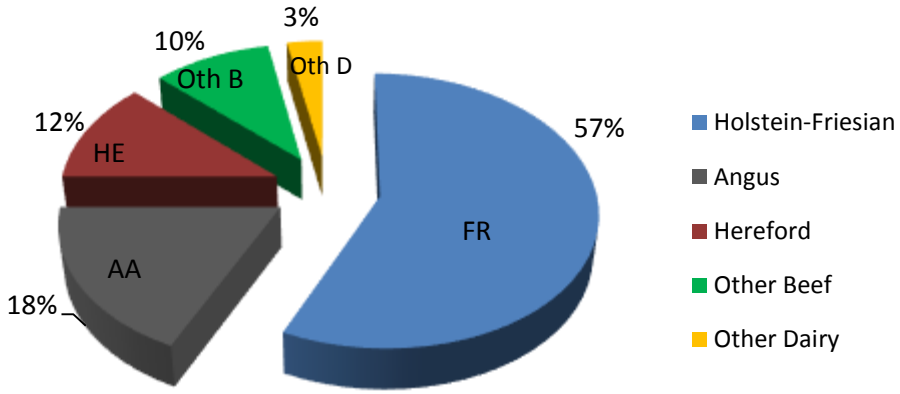

Figure 2: Sire breed profile of calves from the dairy herd (DAFM, 2016)

Along with achieving high conception rates, the primary breeding goal of most dairy farms is to produce the required number of replacement heifer calves. In Irish dairy herds, beef bulls have traditionally been used at the end of the breeding season, after most cows have been inseminated with dairy AI. Beef-crosses generally achieve significantly higher prices than pure dairy-bred calves. This additional revenue can be a useful income stream for dairy producers. Sires should be selected for calving ease, short gestation and calf quality.

The reason beef-cross calves command a price premium over pure dairy-bred calves is largely on account of their higher performance and future saleability (ICBF, 2016). In general, beef crosses result in faster growth rates, superior carcase grading and higher kill-out percentages. These factors are also influenced by the merit of the individual sire used. There has been considerable success in recent years in the development of several breed-specific beef programmes. Finishers receive price bonuses for suitable Angus and Hereford-sired cattle. Animals of these breeds usually finish earlier than either pure Holstein-Friesians or continental-crosses.

Sire Breed	Sex (M/F)	Av. Price Paid
Hol/Friesian	M	€97
Angus	M	€231
Hereford	M	€289
Limousin	M	€288
Belgian Blue	M	€340
Jersey	M	€30

Sire Breed	Sex (M/F)	Av. Price Paid
Hol/Friesian	F	€139
Angus	F	€213
Hereford	F	€259
Limousin	F	€277
Belgian Blue	F	€324
Jersey	F	€95

Table 3: Average mart prices of calves from the dairy herd according to sire breed (ICBF, 2016)

Sexed semen technology is widely used in dairy herds internationally, including in the US and Australia. Specialist laboratory treatment enables the separation of 'female' and 'male' sperm cells. Because of its 'X' chromosome, the 'female' sperm contains 4% more DNA than its male counterpart, which has a 'Y' chromosome. The separation process enables the production of AI straws with a far higher likelihood of breeding a calf of the desired gender. Its commercial application in the Irish dairy herd would be to produce high merit replacement heifers from selected cows at the start of the calving season. Most of the male dairy calves could then be effectively replaced with higher value beef-crosses.

A large-scale field trial was undertaken by Teagasc, ICBF and industry partners (Butler et al., 2014) during the 2013 breeding season to establish the potential for sexed semen use in the Irish dairy herd. Over 15,000 dairy cows and heifers were inseminated using semen from 9 different AI dairy sires on 392 farms throughout the country.

Treatment	Conc. Rate to 1st Service	CR as % of Conventional
Conventional Fresh 3M.	53%	100%
Sexed Fresh 1M.	39%	75%
Sexed Fresh 2M.	46%	87%
Sexed Frozen 2M.	46%	87%

Table 4: Effect of different semen treatments on the conception rates of heifers (Teagasc, 2014)

Treatment	Conc. Rate to 1st Service	CR as % of Conventional
Conventional Fresh 3M.	49%	100%
Sexed Fresh 1M.	32%	64%
Sexed Fresh 2M.	37%	76%
Sexed Frozen 2M.	42%	85%

Table 5: Effect of different semen treatments on the conception rates of cows (Teagasc, 2014)

Four different treatments were assessed, which were “conventional” fresh semen (3m. sperms/dose), sexed fresh semen (1m. sperms/dose), sexed fresh semen (2m. sperms/dose) and sexed frozen semen (2m sperms/dose). As expected, all of the sexed treatments resulted in over 90% of calves born being female. In general, the conception rates achieved by the sexed fresh treatments were disappointing. However, the fertility of the sexed frozen semen was very encouraging. There was wide variation in the conception rates (from <30% to >60%) achieved on different farms. Difficult weather and scarce fodder supplies in spring 2013 meant that cows were generally slightly below target body condition.

Interestingly, semen from certain bulls tends to survive the sexing process more successfully than others, even though for conventional purposes the samples would be equivalent. At present the level of uptake of sexed semen on commercial dairy farms remains very low. Where used, it is most popular with heifers, where the drop in conception rate compared with conventional semen is relatively low (46% vs 53% in the trial). For mature cows, many producers regard the cost as prohibitive (2-3 times that of conventional), along with the risk of extending the calving interval, which is of fundamental importance in a compact spring calving herd. It would be interesting to see the research extended beyond the one-year trial.

1.1.1 Padraig O'Brien, Tallow, Co. Waterford

Padraig O'Brien returned to the family dairy farm in 2011, having worked for several years in management in the manufacturing industry. He was keen to develop the farm business, and rented a neighbouring tillage farm which has been successfully converted to grazing paddocks. Padraig invested in farm roadways, housing and milking facilities, and doubled his herd size to 180 cows. This farm differs from most Irish dairy enterprises in its replacement strategy. Instead of inseminating most of the herd to recommended dairy sires, and keeping the resulting heifers on farm for two years, all replacements are bought in. The rationale for this is to maximise the farm's resources using the milking herd. Heifer rearing represents a significant expense on dairy farms in terms of feed, housing and labour. Teagasc estimates the total cost of rearing a replacement heifer at €1,545 (Teasasc, 2015).

The O'Briens now purchase approximately 30 Holstein-Friesian replacements early each spring. These are sourced directly from known and trusted dairy farmers in the region, usually as freshly calved heifers and young cows with high EBI values. The average price paid in 2016 was approximately €1,400. The entire milking herd is mated to beef sires. The majority are artificially inseminated with Belgian Blue semen, and a Hereford stock bull is used at the end of the season. Blue sires are specially selected for ease of calving, high reliability and colour. When mated with a white Belgian Blue bull, Holstein-Friesian cows will consistently produce nicely-marked blue and white calves. These tend to sell better than calves with black and white coats. The Belgian Blue sires being used are ATG, DBZ, CFU and VSM (Munster Cattle Breeding). Calves are sold at two weeks of age, and this year the Belgian Blues averaged almost €400 each, while the Herefords made €250.

Figure 3: Two-week old Belgian Blue-cross calves from Padraig O'Brien's dairy herd

1.1.2 Morrison Farming, Marton, New Zealand

The Morrison family has been farming since 1864 in Marton, near the small town of Bulls in New Zealand's North Island. Their holding has expanded significantly in recent years, and now consists of 1,430 hectares. This includes 400 ha of fertile flats and 1,030 ha of hill country. Since 2008, the business has operated successfully as a "corporate family farm". There are four equal partners; brothers William and Richard Morrison, their father John and cousin, Graham. Each director has his own responsibilities in accordance with individual interests and strengths. Planning meetings are held each week, along with financial meetings on a monthly basis.

Morrison Farming has extensive sheep and cattle enterprises, which complement one-another well. Approximately 6,000 ewes and hoggets are lambed annually. The herd of 640 pedigree Hereford females calves each September and October. William Morrison describes the core cattle breeding objective as: "to breed quiet polled Hereford cattle that are born easy, grow fast, and can quickly finish to optimum carcase specifications". Traditionally in New Zealand, most Hereford breeders viewed dairy farms as the "poor man's market" for their bulls. However, Morrison Farming has focused specifically on dairy herd requirements, in terms of docile easy-to-handle bulls, low birthweight (in 2014, Morrisons' female calves averaged 34kg and males 36kg), and the calves' subsequent vigour and thrive.

Ezicalve is a programme developed by William along with two other Hereford breeders, to provide a mark of assurance and consistency to bull buyers. The participants are all performance recording their herds under Breedplan; the genetic evaluation system used for beef in New Zealand. This includes birthweight, 200 and 400-day weights, calving ease score, scrotal measurements and carcase scanning. In order to qualify for the Ezicalve brand, a bull must rank in the top five per cent of the breed for low birthweight, and both its sire and dam need to be in the top ten per cent for low birthweight and dairy/maternal index.

Morrison Farming holds its annual bull sale on the farm in late September each year. This is a well-organised event. Sale catalogues are circulated in advance to prospective buyers, with the pedigrees and breeding indexes of all 150 bulls being auctioned. Approximately 120 of the bulls sold are yearlings, which weigh 400-420kg on average at 11-12 months, having being carried on pasture in large groups since weaning. The remainder of the bulls consist of two year olds (which may not have been mature enough to sell the previous year). The

average sale price of the older bulls is approximately NZ$1,000 per head higher than the yearlings ($3,500 vs. $2,500 per head in 2015). However William prefers selling the bulls at yearling stage. The resulting profitability per hectare is almost twice as high as that of the longer, and consequently lower-stocked, production system.

Figure 4: An Ezicalve Hereford bull, bred by William Morrison, with maiden dairy heifers

Along with producing more valuable beef-cross calves, the popularity of Hereford bulls among dairy farmers results from the breed's distinctive white-head marking. Over 55% of New Zealand's 5 million dairy cows consist of either Jerseys or Jersey-crossbreds (Beef and Lamb New Zealand, 2016). Where an Angus sire is used on these, it can often be difficult to distinguish between the newborn Angus-cross calf and a Kiwi-cross. In contrast, there can be no mistaking the Hereford-cross calves.

Shrimpton's Hill Herefords: focusing on gestation length

A commercially important trait which Hereford breeders are increasingly focusing on is that of short gestation length. In recent years, John and Liz McKerchar of Shrimpton's Hill Herefords in Canterbury have partnered with LIC Genetics to develop bloodlines which result in cows calving well-ahead of their expected due date. This technology would also have significant merit on Irish dairy farms, where shorter gestation would deliver extra days in milk and consequently higher annual yields of milk solids. Some of the Hereford bulls bred have a breeding value of 'minus 24 days' for gestation length, which would equate to 12 days earlier calving, on average, at farm level.

1.2 Alternative Systems Available

In order to achieve strong economic returns, it is essential to have a properly planned production system. For all calf-to-beef systems, performance targets should be clearly understood in advance if cattle are to reach their intended sale weight at the desired age. The Beef Production System Guidelines developed by Teagasc are a useful reference point in this regard (Teagasc, 2015). This document outlines the required growth rates and feed inputs for each of the main approaches undertaken by Irish beef farms. The principal methods of dairy calf to beef production are classified according to breed type (male Holstein-Friesian / early maturing cross), gender (steer, young bull or heifer) and the projected age at slaughter.

In Ireland, the majority of male animals continue to be finished as steers. This practice largely complements grass-based production methods and the preferences of most meat plants. Steers represent an important point of difference for Irish beef across continental Europe, where young bull beef is widely available in most markets and considered more of a commodity. The optimum age at which to finish steers varies according to breed-type, month of birth and the level of intensity of the operator. It is common to finish steers at about two years of age. However, with earlier-born Holstein-Friesian calves and crosses of traditional breeds, it is possible to finish at 21 months with appropriate supplementation. Conversely, it may be preferable to retain some animals up to 27 or 28 months of age, for example in the case of late spring born animals which are deemed too light to finish indoors in their second winter. In 2015, some 27% of steers slaughtered in Ireland were over 30 months of age, and therefore missed out on available bonus payments (ICBF, 2016).

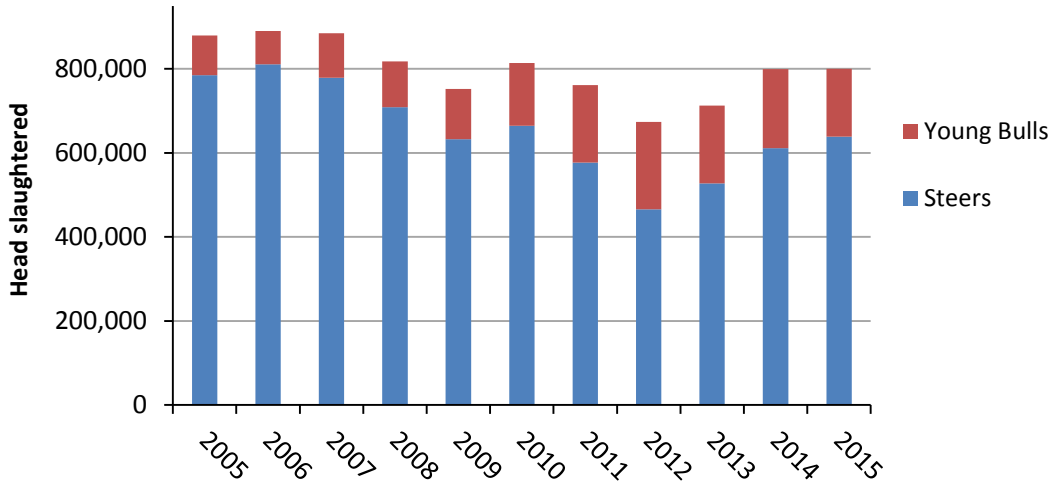

Figure 5: Prime male cattle slaughterings in Ireland 2005 – 2015 (Bord Bia)

In recent years, a considerable proportion of Irish producers have opted to leave male cattle entire for finishing as young bulls. Having previously accounted for less than 10% of prime male cattle, young bull slaughterings reached a peak of over 200,000 head in 2012, when they comprised over 30% of prime males. These systems are quite different to the traditional steer production practiced in Ireland. Producers considering finishing young bulls should be mindful that a high level of management is required. Dairy-bred bulls have a tendency to be quite active, particularly if they become stressed. Robust facilities are required, from housing and handling pens to fencing and water troughs.

Different processors have specific requirements in relation to young bulls, which will be discussed further in chapter 2. An intensive approach to producing Holstein-Friesian young bulls involves finishing at 15 months of age, in order to meet UK customer specifications. Calves born either in early spring or autumn tend to be best suited for this system. Excellent feeding management and attaining sufficient fat cover are key components in achieving performance and profitability in this system. An alternative young bull production system involves slaughtering the animals at between 18 and 20 months of age. This typically relates to animals which are finished intensively indoors following a period at grass during their second year. There are fewer selling options available for bulls of this age. Therefore producers undertaking this system should do so in consultation with a meat plant.

Heifer production focuses primarily on beef-crosses, because the majority of dairy female calves are retained by dairy farmers as replacements. Heifers naturally mature earlier than steers, so they tend to finish at a younger age and a lighter carcase weight. At processor level, heifers consistently command a price premium (normally 10c/kg) over steer carcases. Crosses from traditional breeds should be monitored closely as they come close to finish because they can lay down fat quickly. With good grassland management many heifers can be finished at 19 months, towards the end of the second grazing season. It is also worthwhile to consider selling suitable beef-cross heifers as suckler replacements. These tend to have good milk production, fertility and temperament. There is strong demand for heifers with a good maternal index figures, verified using ICBF data.

System Type	24-month Steer	28-month Steer	15-month Bull	19-month Bull
Liveweight at Finish (kg)	620	680	520	600
Carcase Weight (kg)	320	350	270	320
Conformation	O=	O=	O=	O=
Fat Class	3	3	2+	2+
Concentrate Inputs (t)	1.0	0.5	2.2	1.5
Silage (t)	6.0	8.0	1.2	3.0
Gross Margin / Head (€)	460	590	235	305
Potential Stocking Rate (Cattle finished/ha at 170kg Organic N/ha)	2.2	1.6	4.7	3.4

Table 6: Blueprint targets for the main systems for finishing male Holstein-Friesians (Teagasc, 2016)

System Type	19-month Early Maturing Heifer	23-month EM Steer	26-month EM Steer
Liveweight at Finish (kg)	460	600	620
Carcase Weight (kg)	240	310	320
Conformation	O+	O+	O+
Fat Class	3	3	3
Concentrate Inputs (t)	0.5	0.8	2.2
Silage (t)	3.0	6.0	7.0
Gross Margin / Head (€)	339	493	587
Potential Stocking Rate (Cattle finished/ha at 170kg Organic N/ha)	3.2	2.4	1.9

Table 7: Blueprint targets for the main systems for finishing early maturing crosses (Teagasc, 2016)

The above data relates to research work undertaken by Teagasc at Johnstown Castle, along with its Beef Production System Guidelines. Margin figures are based on the livestock performance achieved and the prevailing prices and costs, which included: steer base price €4.00/kg, Holstein-Friesian bull calf: €100, early-maturing heifer calf: €240, early-maturing bull calf: €270 and concentrate cost of €255 per tonne. The 19 month young bull system allowed for a price discount of €0.30 per kilo against the equivalent steer price.

1.2.1 Michael Murphy, Latteragh, Co. Tipperary

Michael Murphy operates a dairy calf to beef enterprise in Latteragh, Co. Tipperary along with his wife Olivia and four children. The farm consists of 91 hectares of grassland in two divisions; at an average of 800 feet above sea level. Each spring, 280 calves are bought in for rearing. The first 140 of these arrive in February and are male Holstein-Friesians. These calves are reared in two well-ventilated, straw-bedded sheds, with an automatic feeding system in each. After an 8-week rearing period the bull calves are weaned, and a batch of 140 Angus and Hereford-cross heifer calves is purchased in April.

On this farm, an average of 30 to 35kg of milk powder is fed per calf over the rearing period. In Michael's first season to use an automatic feeder, one batch of calves was inadvertently "overfed" and received 40kg of milk powder, rather than the usual 25kg previously given to the manually-fed calves. The machine-fed group were an average of 20kg heavier at weaning. They maintained this advantage through to slaughter, and finished 15kg carcaseweight heavier, two weeks before their conventionally-reared counterparts.

For several years on this farm, male Holstein-Friesian calves were finished intensively as young bulls at 15 months of age. Although animals performed and graded well, the system required a high level of concentrate feeding. The decision was made to focus instead on producing steers and heifers, in order to maximise weight gain from grass. An excellent network of paddocks and temporary fences provides a rotation for the farm's 12 grazing groups. A set of weighing scales is used to monitor animal performance throughout the year. The farm's average stocking rate is an impressive 2.3 livestock units per hectare. Holstein-Friesian steers achieve an average carcase weight of 325kg at 22 months, while the Angus and Hereford-cross heifers are slaughtered at 270kg carcase weight at 18 months.

Figure 6: Michael Murphy, Co. Tipperary with a group of male Holstein-Friesian calves

1.2.2 Midfield Meats, Victoria

Australia is a major global force in the production and export of beef. In 2015, the Australian meat industry processed 9.1 million head of cattle. Beef exports accounted for over 70% of production, or 1.28m. tonnes (PW). Almost 80% of exports are focused on the US, Japanese, Chinese and South Korean markets. Producer prices reached new record highs in 2015, increasing by over 50% on the previous year. The value of Australian prime cattle rose even further in 2016, to over AU$7/kg, above levels in both the EU and US (MLA, 2016).

Established in 1975 by Colin McKenna, the Midfield Group is one of Australia's most successful agribusinesses. Over 1,500 people are employed in Midfield's various divisions including meat processing, transport, a new dairy processing plant, as well as multiple pastoral properties and a retail outlet. Midfield Meats' state-of-the art abattoir in Warrnambool is the largest multi-species meat processing plant in Australia. It has a throughput of more than 2.8 million cattle and small stock annually, and supplies beef, veal, mutton and lamb to over 80 countries worldwide. The McKenna family also owns over 8,000 hectares of agricultural land around Victoria, which includes a dairy enterprise of over 5,000 high-yielding cows, as well as the finishing of 40,000 cattle and 120,000 sheep annually.

Approximately 10,000 of the cattle finished are male Holstein-Friesians, coming from their own and other dairy farms. Every day, calves are delivered to the specialist rearing yard. For the first 21 days, milk replacer is fed twice a day in the pens. After this the calves are moved to small paddocks nearby and fed milk once a day. Weaning takes place at between 8 and 10 weeks, once calves are consuming 2kg of meal per day. Calves stay on the rearing farm until they weigh approximately 150kg. They are then moved to one of the pasture blocks, and managed in a cell-grazing system, with a fresh allocation every two days. Some forage is supplemented at certain times of year. For the final 70 to 90 days, concentrates are supplemented to maximise weight gain and achieve the desired finish.

The McKennas were among the first Australians to adopt a bull beef production system with dairy calves. Other producers are also contracted by Midfield to finish cattle in a similar way. Bull carcases average 310kg at 18 months of age and result in a high saleable meat yield. However, the decision was recently taken to revert to steer production. This was partly because grazing management of the steers is a lot easier. They can be stocked in large mobs of up to 100, whereas 35 is seen as the maximum group size for forward bulls.

There also tends to be a higher labour requirement with the bulls, from moving and monitoring stock to repairing facilities, fences, drinkers and holes in paddocks. At a similar age, the steer carcases are expected to average 280kg in weight. In spite of lighter carcase weights and lower meat yields, steers have a market advantage, especially for the steak cuts which command higher prices than for those coming from young bull carcases.

Figure 7: Members of Midfield's calf rearing team, who rear over 10,000 male calves per year

At over 13 million head, beef cows greatly outnumber dairy in Australia. However, 70% of the national dairy herd of 1.75 million cows is located in Victoria. It is estimated that close to 700,000 male dairy calves are processed nationally each year at approximately one week old. Dairy Australia is a levy-funded organisation for the industry, and is proactive in identifying possible reputational risks. In recent years, the "bobby" veal sector has been prioritised, and a series of standards has been developed in collaboration with the Australian Department of Agriculture and Water Resources, MLA, producer and processor representatives and universities. These legal requirements, which form part of the Australian Animal Welfare Standards for Livestock, stipulate how calves for processing must be treated by all operators along the supply chain, including farmers, calf buyers, saleyards, transporters and meat processors. Conditions include age (minimum of five days), health, feeding, handling, traceability (EID tagging), transport (maximum 12 hours) and food safety (monitoring possible residue issues). Dairy Australia's extension programmes and industry communication have been highly successful in encouraging widespread buy-in to the welfare standards.

1.2.3 Harris Feeding Company, California

Located in California's San Joaquin Valley, Harris Feeding Company is the largest beef producer on the West Coast of the US and the 14th largest nationally. The feedlot covers an area of 600 acres, and has a capacity of 125,000 head of cattle at a time. This enterprise is part of the family-owned Harris Farms group, whose integrated farming operations also include fruit and vegetable growing, a major beef processing plant and a chain of steakhouse restaurants.

During 2014 and 2015, US feeder cattle registered record price increases, before declining again almost as rapidly. This volatility was fuelled by a combination of factors including a drought-induced liquidation of suckler beef herds, followed by subsequent rebuilding. Increases in US production of poultry and pork also had an impact, as did the dramatic increase in beef carcase weights. Many US beef producers opt to reduce their exposure to market volatility though the use of futures markets or forward-price contracts.

Harris Feeding Company is flexible regarding the type of cattle it sources for feeding. Well-bred steers and heifers are purchased through salebarns or directly from farms. Some are even imported from Mexico. However, in recent years Holstein steers have comprised a growing proportion of the animals being bought-in. Although these don't achieve as high a carcase weight or meat yield as the beef-bred cattle, farm manager Tucker Kuntz has been impressed by the health and performance of the young Holsteins, and by the quality of their beef. They arrive as weaned, castrated calves weighing 140-150kg at 4-5 months of age. Groups are sorted by weight, dosed and vaccinated. Mortality rates are well below 1%.

The ration mix is prepared in the farm's feed mill and distributed to the pens in feeding trucks. Initially the diet contains more forage (alfalfa and oaten hay), but as the cattle acclimatise, levels of corn (maize grain), wet distillers grain (by-product of ethanol production) and other supplements are increased. Holstein steers are fed for an average of 300 days. Average daily gain is between 1.3 and 1.4 kg, producing carcases of 310 to 330kg. Dairybred carcases typically grade Choice, rather than Prime, on the USDA scale. This is because of their lesser muscling and external fat than Angus or other popular beef breeds. However, the Holstein steers have been found to develop marbling or intramuscular fat, at a lower level of external fat. The beef resulting from this system is proving highly popular among both restaurant and retail customers.

Figure 8: Holstein steers at Harris Feeding Company, California, which feeds 125,000 cattle

Unlike European producers, US feedlots may legally administer various products to cattle to improve their growth rates and feed conversion. In-feed antimicrobials are used to enhance digestion and therefore feed utilisation. Beta agonists can also be added to feed, typically in the last 60 days of finishing, which increase carcase dressing percentage, or kill-out. Hormone implants are regularly applied under the skin of the ear, and these benefit feed intake, daily gain and feed efficiency (USDA, 2013).

2. Producing for the market

Along with on-farm efficiency, beef producers need to focus on market requirements in order to maximise economic returns. As part of the national Beef Forum, Bord Bia, with the cooperation of Meat Industry Ireland (MII) and its members, conducted extensive analysis of the market profile of Irish beef sales in recent years (Beef Roundtable, 2015). The resulting data was classified according to destination country, channel (retail, foodservice and manufacturing) and cut type (steak cuts, round cuts, forequarter / VL's). This exercise confirmed some interesting information regarding the market profile of Irish beef:

- Almost 90% of Ireland's beef production is exported (510,000 tonnes in 2015).
- Over 95% of Irish beef exports are currently destined for other EU markets.
- Carcase sales represent just 8% of exports.
- The vast majority of Irish beef is now traded as chilled boneless cuts.
- UK is the dominant market (54% of exports), especially for forequarter & round cuts.
- Other EU countries account for 43% of exports. The various continental markets are important for different cuts. For example, France for VL's & ribs, Italy for steak and forequarter cuts, the Netherlands for forequarter & round cuts, Germany and Belgium for steak cuts, Scandinavia for VL's etc.
- Principal channels are retail (43%), foodservice (33%) and manufacturing (24%). There was a similar breakdown for both UK and continental EU markets.
- Over 85 EU supermarket chains purchase Irish beef: more than any other origin.

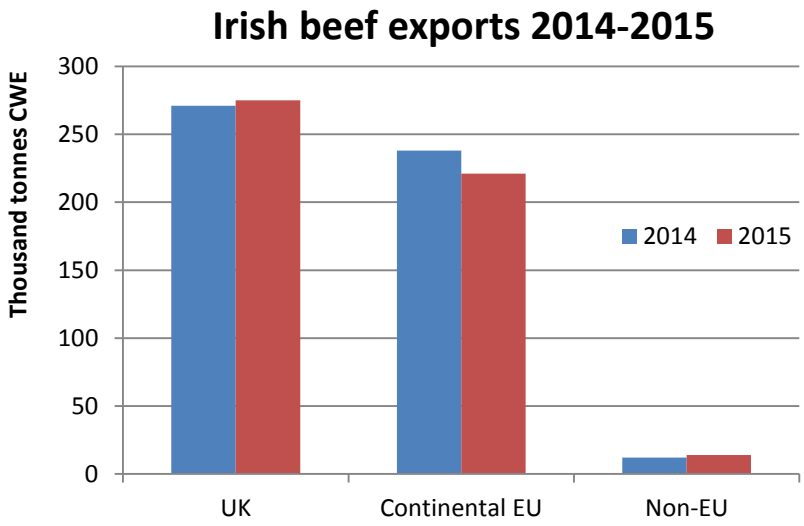

Figure 9: Chart showing Irish beef export markets by volume 2014-2015 (Bord Bia)

As the market analysis indicates, the 20+ primal cuts that come from a particular beef carcase are sold to numerous different customers across several markets. The specific sales channels are determined by where the highest prices are to be achieved. Market demand is influenced by the time of year, promotional activity, availability of competing proteins (other beef, pork, poultry etc.) and economic factors including consumer spending power.

The major retail and foodservice customers have defined purchasing criteria with regard to the beef that they buy. These requirements specify the class of animals that the supplier may select from (heifer, steer, young bull or cow), any upper age limit, along with their permitted range for carcase weight, conformation and fat class. Farm Quality Assurance is also a prerequisite for the vast majority of outlets. Besides these primary conditions, many also make stipulations regarding the weight, shape and fat cover of the individual primal cuts. This is of particular importance where the higher-value steak cuts are concerned. The fillet, striploin, ribeye and rump collectively account for just 12% of the carcase weight, on average, but they typically comprise over a third of the overall value.

Throughout Europe, most supermarkets and high-end restaurants have a preference for steak cuts within a particular range of size, weight and fat cover. Both channels are increasingly looking to present consumers with steaks which meet a desired price point. For example, this can be easily achieved using moderate-sized striploins (5.0-7.5kg), which may be easily portioned into steaks weighing between 200 and 300 grams and of a standard thickness. Steak cuts that do not meet premium customer requirements are usually sold on the wholesale market, but at a discounted price.

Figure 10: European retailers are increasingly seeking to present consumers with steaks that present well and meet a desired price point

Beef finishers should discuss the preferred carcase specifications with their intended meat plant, ideally well in advance of having animals to sell. The preferences of different processors are likely to vary somewhat, according to the particular markets and customers they supply. Companies with major retail accounts in Ireland and the UK tend to focus on steers and heifers aged under 30 months, within a carcase weight range of 280-380kg. Buying criteria for other European markets tend to be less specific. However, cuts of beef from the same carcase category are also favoured on account of consistent eating quality and presentation.

Fat class and conformation also have a significant impact on the market-suitability of a carcase. A carcase fat class of either 3 or 4- is considered ideal by most customers. Carcases with a fat class of 2= or below are deemed to be underfinished, as their beef is likely to have inferior eating quality. Similarly, carcases with a fat score of 4+ or higher are deemed overfat, and result in reduced meat yield and less visually appealing beef.

Conformation is also important because better-shaped carcases generate a higher yield of saleable meat. That is, a higher proportion of high value cuts and consequently a lesser quantity of fat and bone. Carcases with poor conformation (e.g. P grades) will have lower meat yield and produce narrower-shaped cuts of meat.

The Quality Payment System (QPS) is the industry's mechanism for valuation of prime cattle. The QPS is based on independent research by Teagasc (Drennan, 2006), which recommended a 2% price differential between the respective sub classes of fat and conformation. Carcases are mechanically graded using video image analysis (VIA). The actual price paid is determined by the agreed base price adjusted according to the grid summarised below:

	U+	**U=**	**U-**	**R+**	**R=**	**R-**	**O+**	**O=**	**O-**	**P+**
2+	+24	+18	+12	+6	Base	Base	-18	-24	-30	-36
3	+24	+18	+12	+6	Base	Base	-12	-18	-24	-30
4-	+24	+18	+12	+6	Base	Base	-12	-18	-24	-30
4=	+24	+18	+12	+6	Base	Base	-12	-24	-30	-36
4+	+18	+12	+6	0	-6	-6	-18	-24	-30	-36
5	0	-6	-12	-18	-24	-24	-36	-42	-48	-54

Table 8: Quality Payment System (QPS) 'grid': the valuation mechanism for prime cattle in Ireland

As part of the QPS, a price premium was also introduced to incentivise the production of animals in line with certain market requirements. This payment of 12c/kg, known as the "in-spec bonus", is paid on animals which:

- Come from a Bord Bia Quality Assured farm
- Are aged under 30 months at slaughter (steers & heifers), or 16 months (young bulls)
- Meet the eligible conformation (O= or better) and fat class (2+, 3, 4- or 4=) grades
- Satisfy residency criteria (at least 70 days on final farm & maximum of 3 movements)

Communication between processors and producers regarding market requirements, and the acceptability of certain categories of animals, has historically not been as clear as it should be. This has been especially the case for carcases which fall outside the above "in spec" criteria, such as older young bulls or cattle with poor finish or conformation. At times when prime cattle are in short supply, "out of spec" animals usually experience little difficulty in selling and incur minimal penalties. However, when supplies are strong, farmers trying to market the same type of cattle tend to find that "the bar has been raised" in terms of what the market is demanding. "That's just supply and demand" many may argue, but the industry needs to be consistent in the signals it gives to producers.

International Markets for Irish Beef

In recent years, Irish beef exports outside of Europe have focused on markets such as Hong Kong, the Philippines, Russia (currently closed due to embargo) and since 2015 the United States (whole muscle cuts). The industry is also reliant on international markets for many of its offal products which are not valued in Europe, and for hides (Bord Bia, 2016). In terms of increasing market access, the Irish beef industry's primary targets are the US manufacturing sector and China. Both of these appear promising prospects in the near future.

The US market imported 1.08 million tonnes (PW) of beef in 2015, which was mainly destined for grinding, or burger production (USDA, 2016). The technical requirements to supply this market segment are more demanding than for whole-muscle cuts for steaking or roasting. The USDA requires additional microbial testing for the presence of certain pathogenic bacteria, known as STEC. Meat plants in the US reduce this food safety risk by treating carcases with a lactic acid solution in the abattoir, a practice which would not be acceptable to most EU customers. It is anticipated that the already excellent hygiene standards and rigorous controls of the Irish meat industry, alongside efforts at farm level to deliver clean cattle, will enable this opportunity to be realised.

In relation to China, Irish beef exporters are optimistic that the opening of this market will deliver significant opportunities, as it has done for the Irish dairy and pigmeat sectors. Official statistics highlight a 60% increase in Chinese beef imports during 2015, when volumes reached 473,000 tonnes (PW). The Department of Agriculture, Food and the Marine is working closely with the Chinese authorities to finalise the remaining technical steps to allow the trade to commence.

Looking at the medium to long term prospects, population growth is a key factor driving the global demand for food. By 2025 the world's population will have risen to over 8 billion, and by 2050 it is projected to reach 9.7 billion. The number of middle-class consumers looks set to increase even more dramatically, which will shift dietary habits toward more protein based foods, predominantly in Asia (UN Dept. of Economic and Social Affairs, 2015). The resulting uplift in beef consumption is expected to be less significant than for poultry and pork, which are more competitively priced. While Europe looks set to remain the primary destination for Irish beef exports, exports to international markets including the US, Asia and the MENA region are likely to grow substantially from their current levels.

2.1 Blade Farming, ABP Ireland

In operation since 2001, Blade Farming was developed in the UK by its Managing Director Richard Phelps to provide farmers with a new innovative blueprint for beef production. Under the highly-integrated programme, calves are sourced directly from dairy producers at 2 weeks of age and moved to contract rearing farms that grow them until 12 weeks old. The calf rearer doesn't actually buy and sell the calves, but instead receives a management fee per calf per day in return for meeting pre-agreed performance targets. Blade sells the healthy reared calves on to a finisher, who at this point is given a forward price agreement for the animals when they are finished. Farmers receive advice and assistance throughout the cycle on calf management, animal health, nutrition and selection for slaughter.

Blade Farming became part of the ABP Food Group in 2011, upon the acquisition of its parent company RWM (also in beef and lamb processing). This expanding programme continues to deliver a risk management solution not traditionally available in the beef sector. In the UK, participating farmers can opt to specialise in either intensive finishing of Holstein-Friesian young bulls, or steer and heifer production using dairy-beef crosses. The system enables a predictable supply of uniform quality carcases to ABP's meat plants. Major UK customers are convinced by the consistently high eating quality of Blade beef, as well as the high welfare and sustainability credentials of its production.

In addition to over 25,000 calves reared annually in the UK, in recent years ABP Food Group has also offered forward price agreements to Irish beef producers through Blade Farming. In spring 2016, over 3,000 Angus-cross and Hereford-cross calves were placed on specialist rearing farms. As weaned calves at an average of 120kg liveweight, these were sold on to finishing farms. The participating farmers are assured a guaranteed minimum base price for these animals when they are slaughtered, along with the price premiums payable under the breed-specific branded programmes, Certified Irish Angus and Irish Hereford Prime.

Figure 11: Angus & Hereford-cross cattle on the Sheppards' farm, Co. Carlow, participants in Blade

2.2 Adam Buitelaar, Buitelaar Farming, UK

Adam Buitelaar is Managing Director of a fifth-generation meat and livestock business spanning production, processing and trading. From its Irish headquarters in Co. Kildare, Buitelaar is a leading exporter of young stock to continental EU markets. The company's UK division has established an integrated supply-chain for the production of dairy-bred beef.

Applying Buitelaar's extensive knowledge of the Dutch veal sector, they saw an opportunity to add value to dairy bull calves by producing rosé veal for the British market. The highly successful programme is now marketing over 550 finished cattle per week on a year-round basis. These animals are custom-processed by Woodheads' plant in Spalding and the resulting meat is sold into several key retail and foodservice accounts.

Some dairy farmers retain their bull calves through to finish. However, the majority are delivered at 2-4 weeks of age to Buitelaar's four regional collection centres. At this point, calves are either sold directly to a rearer-finisher, or placed into one of Buitelaar's dedicated calf rearing units until they reach approximately 120kg. From the time they buy the calf, farmers are guaranteed a minimum underwritten price that they will receive at slaughter.

Gary Allis of Furze Hill Farm, Lincolnshire supplies over 1,400 head per year to the Buitelaar Rosé Veal Scheme. Every two weeks, he buys in 60 young Holstein-Friesian bull calves, which are reared on milk replacer for 8 weeks before weaning. Gary's bulls are slaughtered at an average carcase weight of 232kg under 12 months of age. This exceptional performance may be attributed to precise attention to detail with regard to rearing, health and feeding. His high-energy feeding regime incorporates low cost by-products from the bakery, confectionary and distilling industries. Controlling input costs and knowing in advance the selling price of his cattle give Gary the confidence to grow his business.

Figure 12: Gary Allis, Lincolnshire supplies 1,400 head per year to the Buitelaar Rosé Veal Scheme

2.3 Greenlea Premier Meats, Hamilton, New Zealand

New Zealand agriculture is globally acclaimed for its dairy and sheepmeat production. However, the Kiwi beef sector is also a significant one, and utilises cattle of both dairy and suckler origin. As in Ireland, their industry is highly-export focused.

Beef herd (June 2015)	3.6 million (of which: 1.0m. suckler cows)
Dairy herd (June 2015)	6.4 million (of which: 5.0m. dairy cows)
Export slaughterings (2015)	2.7 million cattle (& 2.1m. calves)
Beef & veal exports (volume)	431,853 t. (PW)
Beef & veal exports (value)	NZ $3.18 b. (FOB)
Principal markets (by volume)	US (50%), China (17%), other Asia (17%)

Table 9: New Zealand beef sector statistics for 2015 (Beef & Lamb New Zealand)

Greenlea Premier Meats is a major beef processor in the heart of New Zealand's farming-rich Waikato region. The family-owned company was established in 1993, and now processes over 230,000 adult cattle per year through its two sites in Hamilton and Morrinsville. The plants employ 450 staff, spread over two processing shifts, six days per week. Productivity is among the highest in the industry. The company invests regularly in modern technology, including Marel deboning systems and state-of-the-art freezing works. Greenlea can supply most markets worldwide, with extensive accreditation including USDA, EU, individual customers (McDonalds, Burger King & Woolworths) and Halal certification.

Meat processing at Greenlea is significantly different to the practices used in Ireland and across Europe. Most carcases are hot-boned, which means that they are transferred directly from the abattoir to the deboning room without undergoing a period of refrigeration. This system achieves major cost savings and yield benefits in comparison with the conventional approach whereby carcases are chilled for several days before cutting. After deboning, the majority of cuts are placed in boxes for freezing. Some of the higher-value cuts are sold in chilled form, and given 112 days of shelf life (usually 42-60 days in EU). The hot-boned primals are first rolled in cling-film to set their shape before vacuum packing (Cryovac 8600). The cuts are then carefully placed into sectioned cartons for chilling and maturation.

While the carcases from cull cows and manufacturing bulls are hot-boned, steers and heifers undergo a different treatment process, known as warm-boning. Their carcases are placed in a high-humidity chill for 12-14 hours, when they reach a core temperature of 10 degrees

Celsius. This short chilling period allows the prime beef to set, resulting in superior presentation of cuts compared to hot boning. Average carcase weight loss during chilling is less than 0.5%, compared with approximately 2.0% for conventional carcase refrigeration.

Figure 13: Greenlea Procurement Buyer Graham Thomas with producers of beef X dairy steers

New Zealand beef producer prices rose by more than 25% in 2015 on the previous year's levels. Manufacturing bull prices averaged over NZ$5.00/kg carcase weight. This category, which accounted for almost 500,000 slaughterings, relates primarily to pure dairy bulls produced on an extensive, grass-based system. They are slaughtered at between 18 and 28 months of age and carcase weights range from 260 to 360kg. Their carcases would mostly be considered too lean (fat score 1 or 2-) for the European market. However, New Zealand processors have found valuable outlets for lean beef cuts in North America and Asia.

In 2012, Greenlea added a calf processing facility to its plant at Morrinsville, which now slaughters over 120,000 calves per year during the peak calving months of July, August and September. As referred to above, beef farmers buy many of the better-quality male Holstein-Friesian calves to rear for bull production. Unfortunately however, there tends to be little or no producer-demand for a large number of the plainer calves, especially the Jersey crosses. To make use of this unwanted by-product and avert potential welfare issues, the New Zealand processing industry now slaughters more than 2 million dairy calves per year. Meat plants organise the collection from farms and dairy farmers are paid approximately NZ$35 per calf. Calves need to be at least 4 days old, healthy and well-fed. The resulting meat is exported to markets in Asia and the Middle-East. Edible offal products are also recovered, including the tongue, liver, heart and abomasum (for rennet production) (Greenlea Bulletin, 2014).

2.4 Firstlight Foods, Hawkes Bay, New Zealand

Firstlight Foods was founded by Managing Director Gerard Hickey in 2003. Its objective is to deliver premium grass-fed Wagyu beef and Red deer venison from New Zealand farmers to the best customers in the world. The company has successfully established a value chain, which now markets in excess of 30,000 specially-bred-and-grazed cattle per year.

Early on, Gerard spotted the opportunity to enable participating dairy farmers to add significant value to their calf crop. Under the programme, a proportion of their herd is inseminated to purebred Wagyu sires using AI. This breed is traditionally associated with intensive indoor "pampering" of cattle in its native Japan. However, Firstlight has selected bloodlines that will still deliver the characteristic marbling using an all-grazing system.

At all stages of the chain, producers have the assurance of knowing in advance what their selling price will be. Prior to insemination, the dairy farmer is guaranteed a price for the Wagyu-cross calf, which was either NZ$150 per calf at 1-2 weeks old, or NZ$450 if they chose to rear them to 12 weeks or approximately 90kg. The beef farmers who purchase the calves are also contracted to a guaranteed minimum price, which is set around 18 months in advance. This tends to be at least 20% ahead of the prevailing prime cattle price (NZ$6.50/kg vs. NZ$5.25). Heifers are slaughtered at an average of 24 months at about 260-270kg carcase weight, compared to 320-340kg for the steers approaching 30 months.

Meat processing is outsourced to third-party operators, allowing Firstlight to focus on extracting the maximum value from the market. The demand for grass-fed Wagyu beef products is continuing to grow, with premium retail and foodservice customers in the Middle-East (Dubai), the US (California) and even increasingly in Europe and the UK.

Figure 14: Wagyu-cross cattle on Bevan Cameron's farm, who supplies Firstlight Foods

3. The live export route

Ireland has a long history of exporting live cattle. As far back as 1880, German Prussian leader Otto Von Bismarck, on a visit to Ireland, declared that the ideal role for Irish farmers was to produce store cattle for fattening elsewhere in Europe. This proved to be the case for much of the following century, largely driven by a strong appetite for Irish cattle in Britain. When Ireland joined the EEC in 1973, a fledgling beef slaughter industry was beginning to emerge. By the late 70's live shipping to Britain was in permanent decline, as more beef was being sent out "on the hook" rather than "on the hoof".

At this time, Europe shifted from a position of beef-deficit to one of surplus, and export refunds were introduced which compensated selling outside the community below the cost of production. Oil-rich markets in North Africa and the Middle East including Libya, Egypt and Tunisia became the focus for Irish exports of both live cattle and beef. The live contracts comprised mainly of dairy-bred cattle. The BSE crisis of the early 1990's dealt a major blow to Ireland's live and beef trade with international markets. Beef producers in Ireland and other EU countries were supported through intervention and direct subsidies through the CAP. The internal EU market recovered, and an important live export trade developed for calves, weanlings and store cattle between Ireland and other EU countries. In 2015, 1.58 million cattle were slaughtered at Irish meat plants, and just 178,000 head exported live.

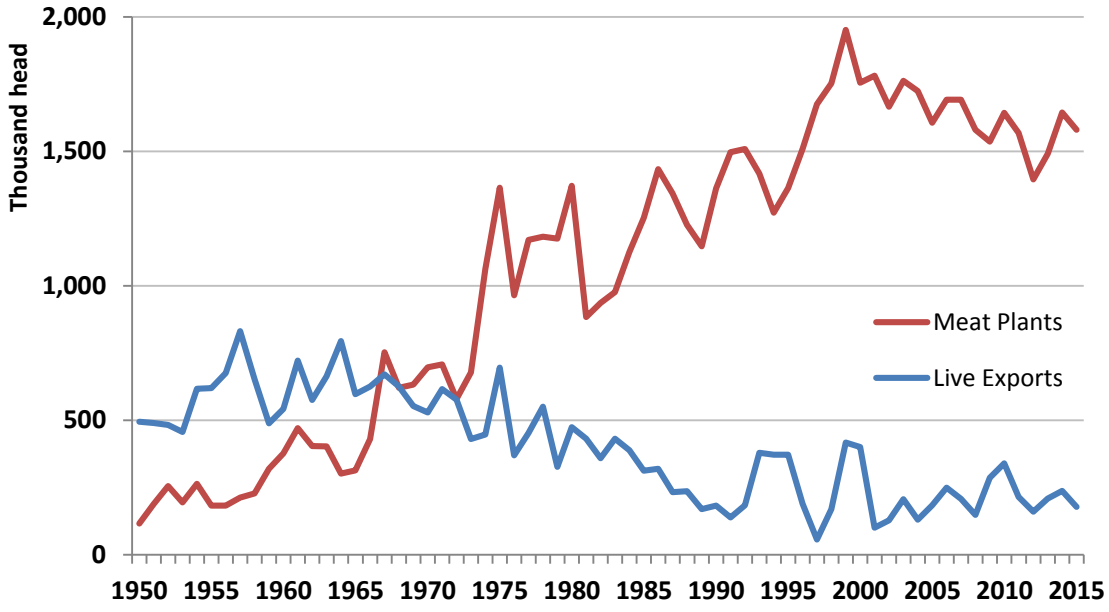

Figure 15: Annual live cattle exports versus slaughterings at meat plants since 1950 (DAFM)

Live cattle exports continue to represent a significant market outlet and an important source of competition for certain categories of stock, particularly for male dairy calves. In certain years, a large proportion of pure dairy bull calves are exported to markets like the Netherlands, France and Spain, where they are finished either as veal or light beef carcases.

Under EU export regulations, calves need to be a minimum of 15 days old before they can be exported. Once they go over 42 days of age, calves need to be TB tested in order to be moved off-farm. Therefore, calves aged between 15 and 35 days tend to be of most interest to export buyers. The younger, lighter calves usually go to the Netherlands for veal, while the slightly older and stronger ones typically go for young bull production in Spain. Holstein-Friesian bull calves make up the vast majority of Irish calf shipments. Crossbred calves with any Jersey influence are not popular among the key export markets on account of slower growth rates, poor feed conversion efficiency and reduced kill-out percentages.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Total Calf Exports	158996	88051	38277	90658	101603	85456
Netherlands	61720	34423	14860	31401	34228	43418
Spain	36317	19982	12990	31240	38162	27420
Belgium	33271	26172	8265	19169	20077	5
France	3027	890	114	6662	5038	8313
Italy	11651	5161	1185	1393	2030	4148
Northern Ireland	12012	1386	825	740	2048	1953
Other EU markets	998	37	38	53	20	199

Table 10: Irish live cattle exports according to market, 2010 – 2015 (DAFM)

Calf exports in 2015 reached over 85,000 head, which represented a 16% decline on the previous year. In 2010 almost 159,000 calves were exported: the highest number in recent years. Calf exports tend to be highly seasonal, reflecting the calving pattern on Irish dairy farms. In 2015, 37%, 28% and 19% of calf exports took place during the months of March, April and May respectively. From a logistics perspective, Ireland has capacity in assembly centres and shipping to handle over 10,000 calves per week. However, the trade is dependent on weather, and during spring 2016 consignments of calves frequently had to be postponed on account of rough sea conditions.

Disease-related issues can have a significant impact on export opportunities. In 2015, Belgium introduced a national control programme for IBR (infectious bovine

rhinotracheitis); a virus that regularly causes respiratory pneumonia in cattle. This has severely restricted Irish exports to that market. Other member states to implement compulsory IBR programmes include Czech Republic, Germany, Austria, Denmark, Finland, Sweden and some regions of Italy. Further loss of export markets is likely if other countries (including the Netherlands) implement similar programmes, unless Ireland does likewise.

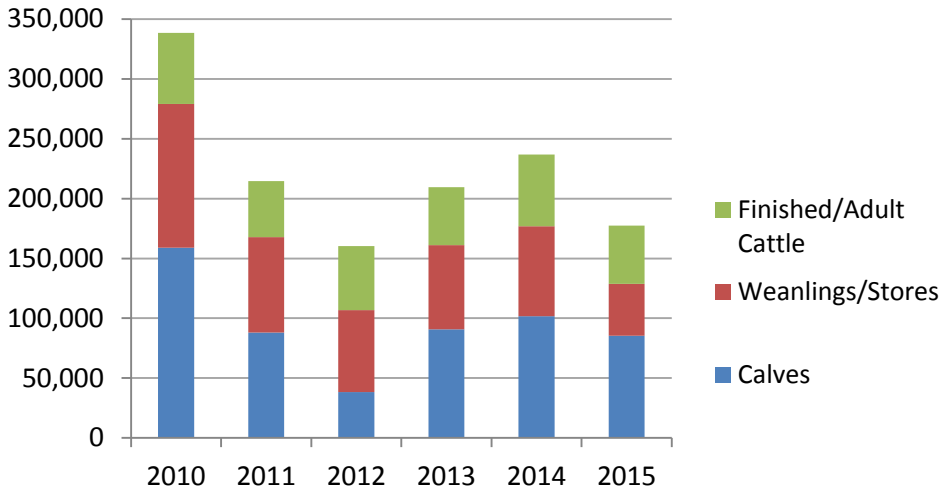

Figure 16: Annual live cattle exports by category: 2010-2015 (DAFM)

Dairy bull calves are usually the largest category within Ireland's annual live cattle exports. Suckler-bred weanling bulls also account for a sizeable proportion of animals exported. Other live markets represent alternative outlets for some dairy-bred stock including:

- Northern Ireland (forward stores, finished cattle, dairy replacements)
- Britain (mainly dairy replacements)
- Spain (well-reared dairy-bred weanling bulls, also dairy-bred Angus-crosses)
- Libya, Lebanon (dairy-bred young bulls)
- Turkey (young bulls, including good quality dairy-beef crosses)
- Egypt (dairy-bred young bulls and steers)
- Russia, Kazakhstan (breeding stock)

Ireland's relatively high cost of transport to most markets is a challenge for live exports, especially where the older animals are concerned. It should also be recognised that when the finished cattle price in Ireland is above the EU average, as has been the case in recent years, Irish animals tend to be less price-competitive for the major livestock markets.

3.1 The Netherlands

Veal is estimated to account for around 8%, or 600,000 tonnes, of the bovine meat produced in Europe (EU Commission, 2015). Alongside France, the Netherlands is the leading veal producer in the EU. Consumption of veal in the Dutch market is small, at just 1.5kg/capita, and over 90% of production is exported. Key markets include Italy, Germany and France. The labelling of veal is controlled by EU legislation. There are two main categorises, according to the age at slaughter, with 'V' denoting less than eight months and 'Z' between eight and twelve months. Production is further differentiated into white veal (traditional, milk-fed, category V) and rosé veal (mostly grain-fed, can be either V or Z). Approximately two thirds of calves are reared for white veal and one third for rosé.

The Dutch veal sector is a highly concentrated and vertically integrated one. The leading processor, Van Drie group, accounts for more than one million head, over 75% of slaughterings annually. There are now fewer than 2,000 Dutch farmers in veal production; a third less than there were 15 years ago. The majority of veal farms operate on a contract basis in conjunction with a processor or other partner. In a similar system to the Irish poultry industry, veal producers are usually provided with the calf and feed inputs and receive a fee for their facilities and management, in line with achieving pre-agreed targets.

Origin	2014	2015	% Change YOY
Bel/Lux	119,818	73,527	-38.6%
Germany	497,674	553,730	11.3%
Denmark	37,631	31,682	-15.8%
Ireland	**41,029**	**41,141**	**0.3%**
Estonia	19,503	15,132	-22.4%
Latvia	28,692	25,650	-10.6%
Lithuania	45,508	28,125	-38.2%
Poland	39,219	28,584	-27.1%
Czech Republic	17,627	16,386	-7.0%
Slovakia	694	0	0.0%
Romania	178	0	0.0%
Total	**847,573**	**813,957**	**-4.0%**

Table 11: Calf imports to the Netherlands by country of origin, 2014 – 2015 (RVO)

Ireland is the third largest calf exporter to the Netherlands, after Germany and Belgium, and a key supplier during the spring months. There are minor discrepancies between the Irish & Dutch statistics, due to re-export of some calves. In addition to annual imports of more than 800,000 head, the Dutch veal industry utilises approximately 750,000 domestic dairy calves.

Klaremelk, Dutch Veal Producer

Klaremelk is a third-generation animal nutrition and integrated farming company, specialising in the formulation of milk-based feedstuffs for young animals. Along with its extensive milk-powder production facility, the Klarenbeek family has built up significant interests in veal production. Niek Klarenbeek recently returned from Romania, where he worked as a livestock trader, to join his father Henk in the farming side of their business. Their veal operation produces up to 50,000 animals per year and spans 40 different farms. They own four of these themselves and the remainder are contracted.

Figure 17: Niek Klarenbeek with one of the company's contract producers of rosé veal calves

Each of these farms follows a professional, systematic approach. Animals are bought and sold on an "all in; all out" basis. The first few weeks are of paramount importance: acclimatising between 600 and 1,200 new arrivals to the system. Their benchmark for mortality is less than 2%, and the farms visited were consistently achieving less than 1% losses. They attribute this success to proactively setting a plan between the farmer, the company and their veterinary practitioner. Similarly, a feeding programme is prescribed for each farm at the start of the cycle, according to the arrival weight of the calves and whether they are to be finished for white veal or rosé.

For white veal, calves should have an arrival weight of at least 48kg. They consume between 260 and 270kg of milk powder before slaughter, along with 250 to 300kg of a specially formulated concentrate. At 7.5 months of age, carcase weights range from 140 to 170kg. Carcase price is dictated by conformation and meat colour. Carcases are downgraded if they are not sufficiently white.

Rosé veal production is effectively a very intensive young bull finishing system. Calves are weaned off milk replacer after 7 weeks, and placed onto a high concentrate diet with maize silage and some chopped straw. Farms targeting to finish rosé calves as category V (< 8 months) generally buy in a better quality calf (>52kg) and raise the specification of their ration in order to achieve similar carcase weights as with the white veal system.

Niek is highly complementary of the quality of the calves he buys from Ireland: “They give very few sickness problems, they know how to drink and within a couple of weeks they develop a lovely healthy shine.” However, it is becoming increasingly difficult to import Irish calves, on account of Dutch movement regulations. In 2011, SKV (Dutch Quality Assurance body) introduced rules which dictate that Irish calves can only be imported as part of a full truckload for finishing; not for resale to other producers. This relates to Ireland’s TB status. Most recently in spring 2016, Dutch authorities implemented a new directive which requires Irish transporters to make an additional feeding stop within 9 hours of departing the resting station in France. This goes above the EU requirement of 12 hours, which was practical for Irish calf consignments to reach their Dutch customers in healthy condition.

3.2 The Spanish market

The Spanish market is an important one in the context of the EU beef and livestock sector. Similar to the Netherlands, cattle production in Spain is highly reliant on live imports, and much of the resulting output is destined for export either in live or processed form. At just 12kg/capita, domestic consumption of beef is low, and has been in decline since the economic crisis began there in 2008.

However, Spanish livestock production has been increasing in recent years, principally driven by export demand. During 2015, beef production grew by 10% to 635,000 tonnes (CWE). Exports of beef increased by 28% to 150,000 tonnes. Shipments of live cattle were also 45% higher, at 180,000 head. Imports of live cattle to Spain reached just over 500,000 head; a slight decline on the previous year. Over 70% of these imports were comprised of calves. Although Ireland supplied fewer calves, increased trade was recorded from other sources including France, Germany and the Czech Republic.

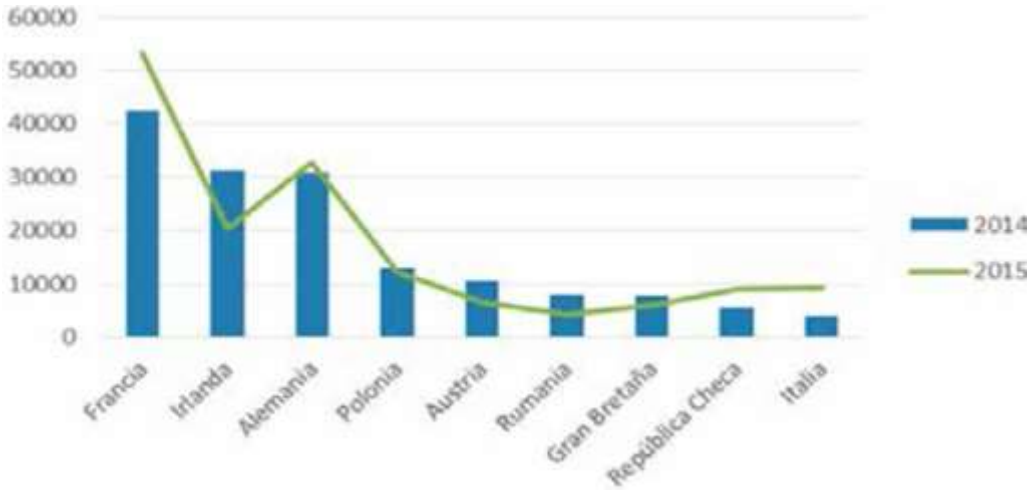

Figure 18: Calf imports to Spain by country of origin, 2014 – 2015 (Asoprovac)

Spain was previously an important destination for exports of Irish weanling bulls and heifers. However, in recent years young calves have become the primary focus of the major livestock buyers there. Responding to the higher prices, irregular availability and frequent health problems associated with the suckled weanlings, Spanish feeders opted instead to purchase more dairy-bred calves. This practice was motivated by their interpretation that the liveweight they could produce themselves through efficient rearing and feeding was costing them less per kilo than the liveweight they were buying in. This was especially the case during recent years as grain prices have been at historic low levels.

On a visit to the north of Spain with an Irish live exporter, the author got the opportunity to meet with calf importers and feedlot owners. The level of performance being achieved by these leading beef producers, with dairy bull calves, is highly impressive. Because of the high summer temperatures, most feedlots are situated in elevated sites, to promote ventilation. Buildings are of a simple open design with loose-bedded flooring.

When it comes to calf selection, Spanish feedlots have a preference for a straight Holstein-Friesian animal with an arrival weight of at least 52kg, but preferably 55kg. Calves are reared in a conventional manner, with milk replacer fed twice daily for 7 weeks, before weaning onto a concentrate-and-straw-based diet. The bulls are finished in loose-bedded pens, with 20-25 animals in each. On some of the farms visited, average carcase weights of 250kg are being achieved at less than 12 months of age, with average daily liveweight gains of 1.4kg/day from rearing to slaughter. Feed conversion efficiency is an important key performance indicator. The top feedlots are getting an FCE of 4.8kg of feed (dry matter) per kg of liveweight gain.

The main concentrate premix used is comprised of 50% maize meal, 30% ground barley, 8% soyabean meal and 6% palm oil, along with vitamins, minerals and acid buff. Ration cost was approximately €230/t (November 2015). Spanish nutritionists do not believe in the inclusion of by-products like pulps, hulls, kernels etc. to provide digestible fibre. Continuous access to good quality fresh straw serves this purpose. Animals feed “little and often” on meal because it is available ad-lib throughout the day.

Figure 19: Irish Angus X Holstein-Friesian calves on a feeding trial in Lleida, Spain

At the time of writing, the average price of O3 grading young bull carcases in Spain was €3.30/kg, some €0.20/kg behind the equivalent price in Ireland. At these levels the Spanish producers explained they were generating a net margin of approximately €80 per head.

3.3 Australian Live Exports

Along with being a major global force in the production and export of beef, Australia is a significant exporter of live cattle. During 2015, live exports totalled more than 1.33 million head, valued at AU$1.47 billion (MLA, 2016). Over 91% of exports related to cattle for slaughter or further feeding, and the remaining 9% were for breeding. Indonesia was the largest market, accounting for 46% of the total exports. The second largest market was Vietnam, taking 23%, followed by China, 6%.

In May 2011, a TV news programme aired footage of Australian animals being mistreated in Indonesian abattoirs. The horrific images ignited a fierce public outcry which led to the Government issuing a blanket ban on live cattle exports to Indonesia. The resulting crisis was especially damaging for farmers in the north of the country, who are especially reliant on this market outlet for the Nelore-type cattle they produce.

The Department of Agriculture, Fisheries and Forestry (DAFF) introduced the Exporter Supply Chain Assurance Scheme (ESCAS), whereby Australian cattle exporters must comply with stringent animal health, welfare and traceability requirements. Under this programme, exporters have a responsibility to ensure that animals are treated responsibly throughout the entire supply chain, including in the destination market. Abattoirs in the importing country need to demonstrate compliant welfare practices and are independently audited.

Figure 20: Part of a consignment of 17,500 feeder cattle to Russia - Landmark International, Portland These animals had cost AU$3.10-3.40/kg liveweight. Holstein breeding heifers were also being bought for export to Russia and China, costing AU$1,500-1,800/head at 3-6 months of age.

4. Sustainability

Sustainability has been defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Commission of the United Nations, 1987). Irish farmers can easily identify with this philosophy. Most farms are passed on from one generation to the next by means of inheritance. The amount of farmland sold annually represents only a fraction of one percent of Ireland’s total agricultural area (Teagasc, 2015).

Global population looks set to reach 9.7 billion people by 2050 (United Nations Population Division, 2015). The planet will need to produce 70% more food, with less land, water and energy while also reducing greenhouse gas emissions. The seemingly-contradictory objective of achieving food security while combatting climate change is one of the world’s most important policy challenges of the 21st century (Bord Bia Origin Green Sustainability Report, 2015).

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global deal on climate change. This agreement sets out a worldwide action plan to limit global warming to well below 2°C. Each nation submitted a comprehensive climate action proposal, whereby the EU committed to reduce greenhouse gas emissions by at least 40% by 2030. Financial penalties are likely to apply where EU member states fail to achieve their target emissions reductions. However, the Paris agreement also recognises that climate action must be conducted “in a manner that does not threaten food production”. In Ireland, one third of emissions come from agriculture, reflecting the sector’s national importance.

Some environmentalists have suggested that Irish agriculture should focus on reducing output to mitigate climate change. However, in that case production would be likely to move to less carbon-efficient countries. Carbon footprint is a measure of the greenhouse gases associated with producing 1kg of output. The principal greenhouse gases from agriculture are methane and nitrous oxide. Methane is associated with rumen fermentation and slurry storage, and accounts almost two thirds of agricultural GHGs. Nitrous Oxide, mainly arising from organic and chemical fertilizer, accounts for the majority of the remaining 1/3 of agricultural emissions. The carbon footprint of Irish food products have

been rated as amongst the best in the EU, according to a major study published by the Joint Research Centre of the EU Commission (2011). The carbon footprint of Irish beef was found to be the fifth lowest in the EU, while the Irish dairy, pigmeat and poultry sectors have the lowest carbon footprints, respectively, of any member state.

The Department of Agriculture, Food and the Marine, supported by the key stakeholders in the industry, has set out a strategic plan to grow the value of agri-food exports to €19 billion over the next decade. Food Wise 2025 identifies opportunities arising from significant population growth and greater access to international markets. The underlying requirement will be to increase production in an efficient and environmentally sustainable manner. The report recognises the critical challenge at farm level for producers to achieve a viable return after the costs of production.

Sustainability is also becoming a key priority at market level. Major global brands including McDonalds, Coca Cola, Nestle and Unilever have made clear commitments in the areas of energy use, waste reduction, social responsibility and sustainable sourcing. Ireland has an opportunity to become a world leader in high quality sustainably produced food. To help achieve this objective, Bord Bia: the Irish Food Board, has developed a unique sustainability programme for the Irish food industry. Launched in 2012, Origin Green is the only sustainability programme in the world which operates on a national scale, uniting government, the private sector and food producers. One aspect of the initiative involves reinforcing the existing strong recognition of Irish food as clean, green and high quality. However, the most important element of Origin Green focuses on delivering measurable improvements in key areas such as emissions, energy, waste, water, biodiversity and social sustainability. At manufacturing level, over 500 food and drink companies, accounting for over 90% of total food and drink exports, have registered to participate in Origin Green.

With regard to the on-farm impact of Origin Green, beef producers in Bord Bia's Quality Assurance scheme (of which there are over 46,000) complete a sustainability survey at the time of the farm audit. This information is used along with individual herd data from AIM and ICBF to assess the carbon footprint of each farm. Feedback is provided, with suggested areas for further improvement. The principal factors influencing the carbon footprint of beef farms include average daily live-weight gain, length of the grazing season, usage pattern of artificial fertilizer, slurry and manure and breeding (suckler cow) performance. Steps to

reduce carbon footprint have also been shown to improve efficiency and thereby raise profitability. This is the basis for the Carbon Navigator, an interactive software tool developed by Teagasc which allows farmers to look at possible changes that can be made on their farm such as improving average daily liveweight gain and extending the grazing season. The Carbon Navigator then illustrates the impacts these changes would have on overall farm profitability and on reducing GHG emissions. There has already been a strong uptake of this technology within Ireland at farm advisory level. Specifically in 2016, over 25,000 Irish livestock farmers will complete a Carbon Navigator as part of the Beef Data and Genomics Programme (BDGP). In the feedback report, results are benchmarked so that each producer can compare their performance with farms practicing a similar system of production.

There is a wide variation between beef farms with regard to the carbon footprint generated. The particular type of production system has been shown to dramatically affect this important measure of environmental sustainability. Beef produced from dairy-bred animals tends to have significantly lower GHG emissions per kilogramme than suckler beef. This is primarily because suckler beef systems require a mature breeding animal to be maintained for the entire year to produce a single weaned calf. From a sustainability perspective, the inputs and emissions associated with the suckler cow are borne by her output: the weanling. By contrast, dairy-bred calves entering the beef enterprise are effectively treated as a by-product. They start off with a minimal “carbon-cost”, because the vast majority of the dairy cow’s inputs and emissions are attributable to her milk production. This advantage of dairy-beef systems is supported by research undertaken by Teagasc, whereby the average carbon footprint of Irish dairy beef systems was evaluated as 14.1 kg CO2eq per kilogramme of carcase weight (Crosson et al., 2010), compared to average emissions of 21.2kg CO2eq/kg carcase for suckler beef systems (Foley et al., 2011).

There is also a great variation between the carbon footprints of farms practicing similar production systems. Much of this disparity is associated with the levels of performance and efficiency being achieved. For example, beef animals with good growth rates throughout their lives result in a lower carbon footprint than ones which go through store periods and consequently take longer to finish. The quantity of inputs used is also taken into account, which benefits farms making optimal use of grazed grass and high quality forage.

4.1 William Morrow

William Morrow from Raphoe, Co. Donegal was the winner of the Origin Green Sustainable Producer Awards in the dairy calf to beef category. The 12 finalists in this competition were selected from over 46,000 Irish beef farms in Bord Bia's Quality Assurance scheme, on the basis of having scored among the top producers in their farm audit and sustainability survey. The Morrows' 60-hectare family farm stood out because of its simplicity and the high level of technical efficiency being achieved in all areas of its beef enterprise.

William buys in 300 Angus and Hereford cross calves annually which are carried through to beef as steers and heifers at just 17-19 months of age. The fact that the farm had experienced no calf mortality in the previous year is a testimony to the excellent standard of stock management and health controls. Calves are purchased over a 6 week period from mid-February to early April and reared in well-bedded and ventilated accommodation.

A high quality milk replacer is fed twice daily and calves consume an average of 25kg each. Concentrates are introduced from an early age and calves are given access to pasture before weaning at 10-12 weeks. As calves get used to grazing, meal feeding is withdrawn. William makes effective use of paddocks and temporary fencing to rotate the grazing groups regularly onto fresh pasture. Sward quality is maintained by topping and making baled silage.

In their first year, animals receive preventative treatment for IBR, Pi3, RSV, Clostridial diseases, worms and fluke. Over the winter, weanlings are fed silage and 1.5kg of concentrates. During the second grazing season, some cereal-based ration is introduced from August onwards, for 4-6 weeks before slaughter. This helps to achieve carcase weights of between 240 and 280kg off grass at a young age.

As demonstrated by the following diagram, the carbon footprint of William Morrow's farm is one third less than that of the average dairy calf to beef producer, and consequently over 50% lower than the national average for suckler beef. William emphasises his achievement is not as a result of anything complex he is doing. He puts it down to doing the simple things very well, in terms of calf selection, monitoring health, grassland management and soil fertility. Along with being environmentally sustainable, these measures are also what make this beef farm amongst the most profitable.

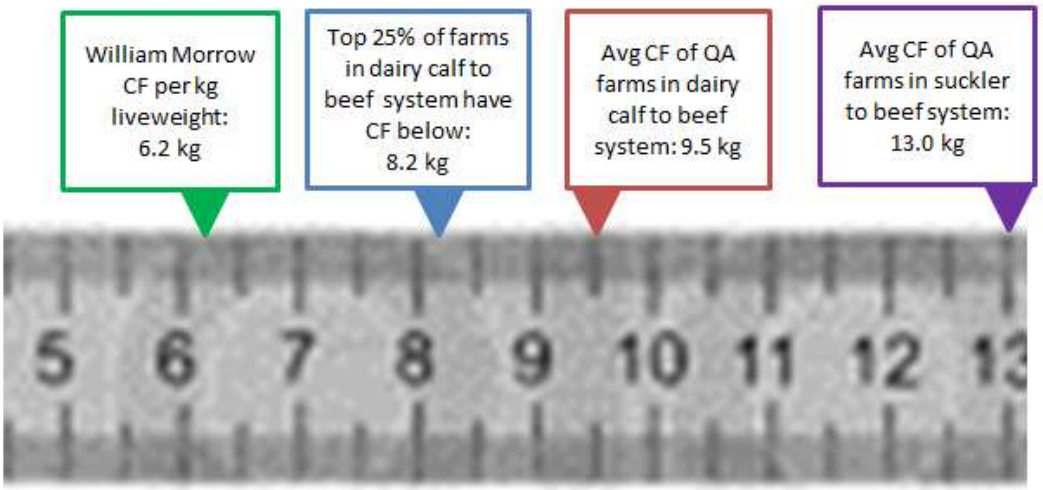

Figure 21: Graph comparing beef carbon footprint (kg CO2 eq/kg liveweight) on William Morrow's farm with the national average for the main production systems (Bord Bia, 2016)

Figure 22: Visiting William Morrow's Farm in Raphoe, Co. Donegal with Aidan Murray, Teagasc

Conclusions

Cattle bred from the dairy herd already represent an important source of quality prime beef for the processing sector. In Ireland, recent dairy expansion is leading to a significant increase in the supply of these animals. They generally produce lighter carcases, with less developed conformation than suckler-bred animals. However, well-managed dairy-beef systems have the potential to sustainable produce consistent quality beef, as well as positive margins at farm level.

The first and most important stage of any dairy-beef production system is the rearing period up until weaning. Research by Teagasc and others has shown that prioritising the nutrition of the calf during the rearing stage not only raises the calf's weaning weight but also its subsequent performance. A target for successful calf rearing should be to achieve average growth rates of 700g per day up to weaning, resulting in 100kg liveweight at 12 weeks.

Producers use several alternative approaches to bring animals to finish, according to farm area, pasture quality and facilities, as well as the experience, skill set and time constraints of the operator. Grass-based farming practices largely complement steer and heifer production. Finishing systems for dairy-bred young bulls are reliant on excellent feeding management and on having a good working relationship with the intended meat processor. For both extensive and intensive systems, it is essential to monitor livestock performance in order for cattle to achieve their target sale weight at the desired age.

There are many examples worldwide of integrated supply chains utilising dairy-bred calves. Most involve either a specialist production system (e.g. rosé veal), or calves of specific breed of sire (e.g. Angus, Hereford, Wagyu). Under these contract arrangements, producers have the security of a minimum guaranteed price for their animals at the beginning of the cycle.

Sixty percent of calf registrations to Irish dairy cows in 2015 were sired by dairy bulls. This has risen from 50% ten years ago. The remainder of calves were sired by beef bulls. Beef-crosses usually achieve significantly higher prices than pure dairy-bred calves. This can be a useful income stream for dairy producers. Sires should be selected for calving ease, short gestation and calf quality. Angus and Hereford are the most popular beef breeds for crossing with dairy cows. There has been considerable success in recent years in the

development of breed-specific beef programmes, which pay bonuses for suitable Angus and Hereford-sired cattle.

Live cattle exports represent an important source of competition and a significant outlet for certain categories of stock, particularly male dairy calves. In certain years, a large proportion of dairy bull calves are exported live to markets like the Netherlands, Spain and France. It should be recognised that when finished cattle prices in Ireland are above those in most other EU markets, Irish live exports tend to be less price-competitive. The sector also faces challenges in high transport costs, stricter regulation and disease-related restrictions.

For food producers, environmental sustainability is seen as the key challenge of the 21st century. The world population is predicted to reach 9.7 billion people by 2050, resulting in a 70% increase in the global demand for food. This will need to be produced with less land, water and resources. The Irish agri-food sector has numerous natural advantages, including that the carbon footprints of Irish food products have been rated as amongst the best in the EU. In the beef sector, there is significant potential to further improve the average carbon footprint. The factors which reduce carbon footprint also tend to benefit the on-farm efficiency and profitability. Progress in this area would also demonstrate that Ireland is honouring its commitments under COP21, Food Wise 2025 and Origin Green. Beef produced from dairy-bred animals tends to have a significantly lower carbon footprint than suckler beef. From a greenhouse gas emissions perspective, the dairy cow's inputs are mainly attributable to her milk production, and so the calf enters the beef enterprise with a minimal "carbon-cost".

To-date the great majority of the Irish dairy herd has been comprised of Holstein-Friesian cows. In some countries where Jersey genetics are prevalent there is no producer demand for a large proportion of the resulting male dairy calves. Many of these animals are processed at approximately a week of age by specialised meat plants. In New Zealand, the practice received widespread negative publicity in 2015, as a result of video footage showing poor welfare practices. The Australian Department of Agriculture and Water Resources has developed a set of legally-binding standards stipulating how calves must be treated by all operators within the supply chain.

Recommendations

1. On account of the growing importance of this system, there is a need for more beef farmers to acquire the skills to successfully rear dairy-bred calves to weaning stage. Teagasc should establish a dedicated research centre focusing on all aspects of dairy calf to beef production. There has been much positive work including trials at Johnstown Castle, as well as the Green Acres and AgriProfit D2B demonstration-farm programmes. The replacement-heifer rearing facilities at Teagasc Moorepark are highly impressive, and could be replicated elsewhere for calves for beef production.
2. The completion of a Dairy-beef Index (DBI) by Teagasc and ICBF will allow dairy producers to more reliably select beef sires for calving ease, short gestation and calf quality. This would give more dairy farmers the confidence to breed their cows and heifers with beef sires, and thereby increase their revenue from calf sales.
3. Teagasc, ICBF and industry stakeholders should consider possibilities for further research in the area of sexed semen technologies. It would be beneficial to see the on-farm trial of 2013 extended, with a focus on the most successful treatment.
4. The Irish beef industry could benefit from adopting certain aspects of the integrated supply chains which operate internationally for dairy-bred animals. Notwithstanding market volatility, the provision of a price security mechanism would ensure a consistent supply of quality, in-spec animals, particularly those required for premium niche markets.
5. The development and promotion of premium beef schemes, which return price bonuses to producers, should continue to be supported by Bord Bia and others. To-date, the higher value has mainly been achieved from the branded steak cuts. However, opportunities to also “premiumise” the forequarter and round cuts need to be maximised.
6. The area of environmental sustainability represents both an opportunity and a challenge for the Irish beef sector. Ireland’s sustainability credentials are well-recognised and the carbon footprint of Irish beef is among the lowest in Europe. However, there is significant potential for further improvement. Every beef producer

in Bord Bia's QA scheme receives a carbon footprint score after their farm audit. This measure also reflects the level of efficiency being achieved. Teagasc and Bord Bia should better engage with farmers in this regard, through discussion groups and uptake of the Carbon Navigator tool.

7. A control programme needs to be developed and implemented for IBR (infectious bovine rhinotracheitis) by the Department of Agriculture, Forestry and the Marine, in conjunction with Animal Health Ireland, to protect Ireland's live export sector. Live exports represent a significant market outlet for dairy bull calves. In 2015, Belgium introduced an IBR control programme which has significantly restricted Irish exports to that market. Further loss of export markets is likely if other countries (including the Netherlands) introduce similar programmes, unless Ireland does likewise.
8. All operators within the livestock sector must be conscious of their "social licence to operate". Irish beef producers rightly pride themselves in having the highest standards of food safety, traceability and animal welfare, but there can be no room for complacency. The importance of having effective systems of regulation is highlighted by some high-profile animal welfare related incidents internationally in recent years.

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