



Teagasc National Beef Conference 2016

‘Practice into Profit’

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Programme

3:15pm Welcome: Tom Kellegher, Teagasc Regional Manager, Longford /Roscommon

3:25pm Opening Address: Professor Gerry Boyle, Teagasc Director

Session One

Optimising Profit in Calf to Beef Systems

Chaired by: Dr. Edward O’Riordan, Teagasc Grange

3:40pm **Alternative finishing strategies for dairy calf to beef systems**
Rob Prendiville & Brian Murphy, Beef Researchers, Teagasc

4:20pm **Some practical factors affecting calf health in indoor calf rearing systems**
Martin Kavanagh, Animal Health Consultant

4:50pm **Operating a profitable and sustainable calf to beef enterprise**
Alan Kehoe, Beef Farmer, Co. Wexford

5:20pm **General Discussion**

5:30pm **Break**

Session Two

Breeding Suckler Cows to Maximise Profitability

Chaired by: Dr. Doreen Corridan, Munster Cattle Breeding Group

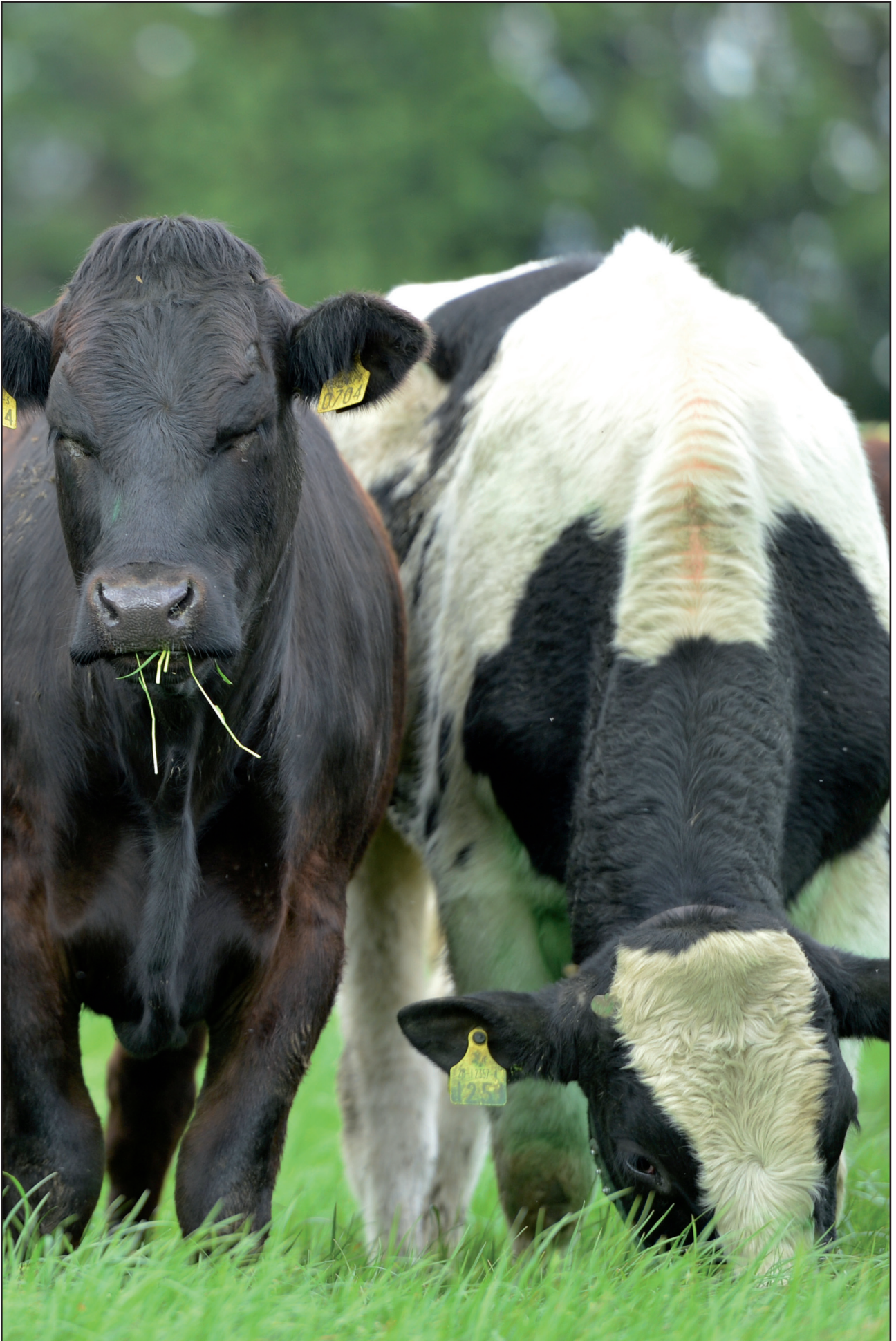
6:30pm **French beef cattle performance recording scheme, impacts and prospects with genomics for the beef industry**
Laurent Griffon, Head of Population Selection and Management Team, Institut de l’Elevage, Paris, France
O. Leudet, Institut de l’Elevage, Paris, France

7:10pm **How the accurate recording of birth weights, weaning weights and other data have helped me to make more informed breeding decisions**
David Clarke, Suckler Beef Farmer, Co. Tipperary

7:40pm **Squeezing more benefits out of genomics**
Donagh Berry, Quantitative Geneticist, Teagasc

8:15pm **General Discussion**

8:30pm **Close of Conference, Frank O’Mara, Teagasc.**





Foreword

You are all very welcome to the Teagasc National Beef Conference for 2016. The theme of this year's conference is 'Practice into Profit' and each of the papers that will be presented will focus on how farmers can improve the profitability of their beef enterprise by putting into practice the key technologies that are available to them, both now and in the coming years, in breeding, grassland management, animal health and financial management. Teagasc, through its own demonstration farms and on the many farms we work with in our joint industry programmes, has clearly shown the real benefits of making the most from new and innovative technologies.

It is now becoming increasingly obvious, as more calves become available from our expanding national dairy herd, that there is a growing interest among Irish beef farmers in purchasing dairy bred beef calves for rearing, or bringing through to beef. The first session of the conference looks at the many different beef systems these calves can be finished in, and the levels of performance that can be achieved in each of them. With many relative newcomers to calf rearing, we will also be examining the key areas that need to be focused on, if calves are to be healthy and well grown, so that they can attain their full potential.

The second session today is looking at the role Irish suckler farmers can play in improving the value of the new beef breeding indexes to their farms when selecting replacements. The launch of the new Genomic Euro-Star beef indexes is undoubtedly a huge step forward for beef breeding in Ireland and is the end result of many years of research by Teagasc, ICBF and the Department of Agriculture, Food and the Marine. However, without the accurate recording of data by suckler farmers the true benefits of this powerful new technology will not be fully realised. The conference will hear how the French breeding programmes have for many years used large amounts of on-farm recorded data to improve the reliability and effectiveness of their beef breeding indexes to make significant advances in their herds.

All Irish beef farmers, and especially those who are participating in the new Beef Data and Genomics Programme and the new Knowledge Transfer Beef Groups, will have the opportunity to learn more about many of the new and exciting technologies that will be discussed at the conference. Putting these technologies into practice is the responsibility of all beef farmers when they are looking at their own farms. As always, Teagasc will play a huge role, in working with both our clients and the beef industry in general, to ensure that these technologies are both sustainable and profitable in the long term. We do this through research, advisory and education programmes on an on-going basis.

Finally I would to thank all of our speakers today for taking the time to prepare for, and present at this conference. I would especially like to thank our farmer presenters for sharing with us what they have learned on their farms. I thank my Teagasc colleagues, at both local and national level, for organising this conference and ensuring it was a success. I sincerely hope that everyone takes something from the different presentations that they can bring back to their own farms and implement, which is the number one objective of today's event.

Professor Gerry Boyle
Director Teagasc

Alternative finishing strategies for dairy calf to beef systems

Robert Prendiville¹, Brian Murphy^{2,3} and Brendan Swan².

¹Animal & Grassland Research and Innovation Centre, Teagasc, Grange, Dunsany, Co. Meath, ²Teagasc, CELUP Johnstown Castle, Co Wexford,

³School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.

Summary

- Growth in the national dairy cow population will result in a proportional increase in the number of dairy calves available for beef production.
- Industry figures show that steers born from the dairy herd accounted for 55% of the national steer kill in 2013.
- Pasture-based early-maturing dairy crossbred beef production systems can produce carcasses that have adequate weight and fat cover at slaughter.
- Systems that utilise high quantities of pasture and are focused on high output per hectare are fundamental to the profitability of production systems.

Introduction

Growth in the national dairy cow population will result in a proportional increase in the number of dairy calves available for beef production. The Irish dairy herd is predominately comprised of spring calving cows managed on seasonal pasture based production systems. Currently approximately 30% (circa 340,000) of dairy calves born are replacement dairy heifers (AIM, 2016). The remaining calves (approximately 840,000 calves) are potentially available for beef production. In general, male dairy calves that remain in Ireland are managed under various dairy calf-to-beef, predominately steer systems, while beef crossbred heifer calves are either operated in low input production systems or retained for breeding in the suckler herd. Presently, male dairy calves represent 41% of calves available for beef production (Figure 1) while 43% are early-maturing crossbred calves (26% Angus and 17% Hereford). Limousin, Belgian Blue and other crossbred dairy calves make up the remainder (approximately 95,000 calves).

Recent industry figures showed that steers born from the dairy herd accounted for 55% of the national steer kill in 2013 (O’Riordan and Cormican, 2013). Male dairy steers had a 325 kg carcass weight, while early-maturing dairy crossbred steers and late-maturing dairy crossbred steers had carcass weights of 335 and 370 kg, respectively. Mean age at slaughter was 29 months for dairy steers which suggests that large proportion of animals were slaughtered greater than 30 months of age. While slaughtering animals during their third season is a profitable production system, slaughtering animals late in the third season at pasture or during their third winter reduces the stocking rate potential of the farm. Ideally animals that are ‘stored’ through the second winter should be slaughtered in May/June to avail of the stronger beef price at that time and also make pasture available to younger stock on the farm.

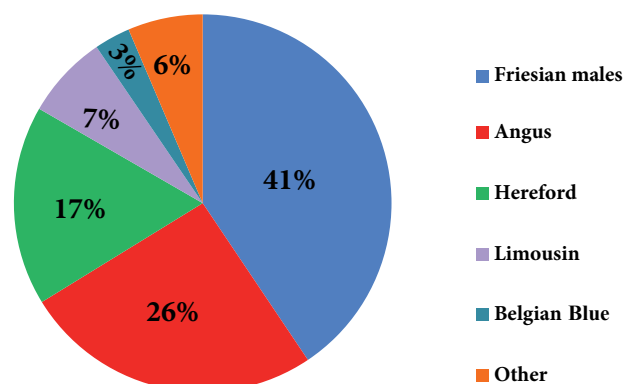


Figure 1: Sire breed profile of dairy calves available for beef production (AIM, 2016).



Purchasing young calves

Approximately 70% of dairy calves available for beef production are traded at less than 6 weeks of age (AIM, 2016). Purchasing healthy dairy calves for beef production is essential to the profit generation of these systems. Assembling dairy calves from multiple sources increases the risk of introducing disease onto the farm. Where possible calves should be purchased from a limited number of sources where information regarding disease status, colostrum supply and feeding regime prior to purchase are available. When rearing dairy calves it is essential that calves have a clean dry lie in a well-ventilated house. Good protocol around hygiene and calf husbandry will also minimise disease risk (Gould and Cooke, 2013). Calves should be offered the appropriate level of milk replacer throughout the rearing phase with *ad libitum* access to ration and roughage (hay or straw). Calves should be 85 kg at weaning and consuming approximately 1 kg of calf ration daily. The calf rearing period is of critical importance to the subsequent performance of the animal. Results from UCD have shown a positive relationship between early life growth and carcass weight (Kelly, 2016 personal communication).

Calf performance during their first grazing season

Optimising calf performance during their first season at pasture is essential to ensure that the targets set out in the blueprints below are achieved. Following the calf rearing stage, calves are typically supplemented with concentrates until mid-May, remain on a pasture only diet until early September and are again supplemented with 1 kg of concentrates daily until housing. Aside from male Holstein-Friesian calves allotted to the 15-month bull production system, the target average daily gain (ADG) of a calf during their first season at grass is 0.80 kg with a live weight target at housing of 230 kg. Male dairy calves assigned to the 15-month bull production system require an ADG of at least 0.90 kg during this period to ensure that they are approximately 250 kg at housing in November. It is essential that good pasture management is adhered to ensure that optimum animal performance is achieved. Animals that are carried through their first winter on a diet comprised of grass silage *ad-libitum* are supplemented with 1.5-2.0 kg of concentrates daily (depending on silage quality). Good quality silage should be available throughout the winter period (>70 DMD). The target ADG during the first winter is 0.70 kg.

Results from Teagasc studies

A series of studies for dairy calf-to-beef systems have been carried out at Johnstown Castle since 2010 which have included alternative finishing strategies for male dairy calves, early-maturing dairy crossbred calves and more recently Limousin dairy crossbreds; the purpose of which was to identify the optimum production system for each breed type. The trials included dairy bull, steer and heifer systems. The performance results, profitability and blueprints for optimum systems for each are outlined below.

Optimum male dairy calf-to-beef systems

- **21-month steer system:** for spring-born calves winter finishing can be avoided by slaughtering cattle at a lighter carcass weight at the end of the second grazing season. Steers are finished at the end of the second grazing season having been supplemented with concentrates for the final 60 days of the grazing season. Concentrate input during the finishing period for this system is 350 kg (5 kg for 60 days pre-slaughter). Calves must have good life time performance and have an early birth date for this system (Jan/Feb born). Target carcass weight is 280 kg (550 kg live weight at slaughter). For Holstein-Friesian steers conformation scores are predominately 'P+ / O-' (85%) with fat scores of '2= / +'. Kill out proportion is 514 g/kg.
- **24-month 'traditional' steer system:** Steers are finished during the second winter, approximately 100 days. In this system finishing occurs during the second winter and cattle are offered good quality grass silage and 5 to 6 kg concentrates. Concentrate input during the finishing period for this system is 600 kg. The target carcass weight is 320 kg (Keane and Allen, 1998, and Keane and Drennan, 2008). Target live weight at slaughter is 620 kg. Conformation scores are predominately 'O' (80%) and the remainder are 'P'. Fat scores are '3'.
- **26-28-month steer systems:** in this system animals are at pasture for the second grazing season. They are then housed on a grass silage only diet for the second winter. During this period animal performance is typically 0.50 kg/day. Steers are then turned out to pasture in late February/early-March and slaughtered in June. Average daily gain during their third season at pasture is approximately 1.3 kg. In this system Holstein-Friesian steers are slaughtered at 28-months of age and achieve a carcass weight of 350 kg. Conformation scores are predominately 'O=' with fat scores of '2+'. In this system approximately 65% of live weight gain is achieved from grazed grass.

Optimum early-maturing calf-to-beef systems

Research at Johnstown Castle examined various finishing strategies for early and late spring born Angus and Hereford dairy crossbred heifers and steers. Results have shown that spring born early-maturing dairy crossbred heifers (February to April born) should be slaughtered at 19 to 21 months of age before the second winter housing (Table 1). Research at Johnstown Castle also examined finishing heifers indoors during their second winter. While a greater carcass weight was achieved, winter finishing costs were inevitably incurred and some heifers were over fat at slaughter. An economical appraisal of that system highlighted that finishing heifers indoors was less profitable than finishing heifers at pasture.

Table 1. Performance results of early maturing heifers and steers.

Month of birth	Heifers				Steers			
	February born		April born		February born		April born	
Slaughter age (month)	19	21	19	21	21	23	21	26
Finish	Pasture	Pasture	Pasture	Indoor	Pasture	Indoor	Indoor	Pasture
Live weight at slaughter (kg)	450	476	446	518	525	607	547	621
Carcass weight (kg)	234	247	234	257	274	308	269	322
Conformation score	O=	O+	O+	O+	O=	O+	O+	O+
Fat score	3-	3=	3-	4-	3+	3+	3+	3+
Kill out proportion (g/kg)	520	518	525	496	521	507	491	519

Early spring born early-maturing steers have the potential to be slaughtered at the end of the second grazing season. Previously, the blueprint for these steers involved a winter finishing period of 80 to 90 days. While both systems were profitable, finishing steers during the second winter was less profitable than pasture finishing. Alternative finishing strategies were also investigated for late born steers. Animals were either finished indoors during the second winter or finished during their third season at pasture at 26-months of age. Results showed that steers that were finished indoors had a lighter carcass weight and that the system was less profitable than finishing animals during their third season at pasture.

The optimum production systems for early-maturing heifers and early and late born early-maturing steers are outlined below.

- **Early-maturing heifer production system:** after their first winter heifers are turned out to pasture in early-March and slaughtered at pasture at end of the second grazing season between September and November (19 to 21 months of age). Target carcass weight for this system is 235 to 250 kg. Carcass conformation for heifer production systems were predominately 'O= / O+' with carcass fat classes of '3- / ='. Results from Johnstown Castle have shown that all spring born heifers should be slaughtered before the second winter.
- **February born steer:** Steers are at pasture for the first grazing season and 'stored' during the first winter on *ad-libitum* grass silage supplemented with 1.5-2.0 kg of concentrate daily depending on silage quality. They are turned out to pasture for the second grazing season and slaughtered at pasture in November. Average daily gain during the second season at pasture is 0.80 kg. The target carcass weight in this system is 280 kg. Average carcass conformation score was 'O=' and carcass fat score was '3-'.
- **23-month early-maturing steer system:** In this system cattle are at pasture for the second grazing season, housed and offered good quality grass silage supplemented with 5-6 kg of concentrates daily for 80 days pre-slaughter. Average daily gain during the finishing phase is 1 kg. The target carcass weight is 300 kg with a conformation score of 'O+' and fat score '3='.
- **April born steer:** Animals are at pasture for the second grazing season and are then housed and offered *ad-libitum* grass silage only for the second winter. During this housing period ADG is typically 0.50 kg. Steers are then turned out to pasture in March and slaughtered in June. Average daily gain during the third season at pasture is 1.3 kg. The target carcass weight is 320 kg with conformation and fat scores of 'O+' and '3+', respectively. This system is particularly well suited to calves born in late spring (April/May) as winter finishing is avoided and a heavier carcass weight is achieved under grazing conditions.



Profitability of dairy calf-to-beef production systems

Figure 2 shows the net margin of the production systems described above based on a 40 hectare farm model. Price assumptions were: male Holstein-Friesian calf purchase price, €100; early-maturing breed heifer calf, €240; early-maturing breed bull calf, €270; R3 steer beef carcass price, €4.00; and, finishing concentrate price, €255. Actual beef price payable depends on carcass grading (animal performance results generated at Johnstown Castle), seasonality (beef price being highest in May and lowest in September) and eligibility for quality assurance bonus. Breed bonuses were included for the early-maturing breed production systems.

Results clearly indicated that variation in profit exists across production systems. Although the traditional production systems for male dairy calves and early-maturing breed heifer and steer production systems were profitable, grass-based production systems where animals were slaughtered in November before the second winter or in June during their third grazing season were the most profitable.

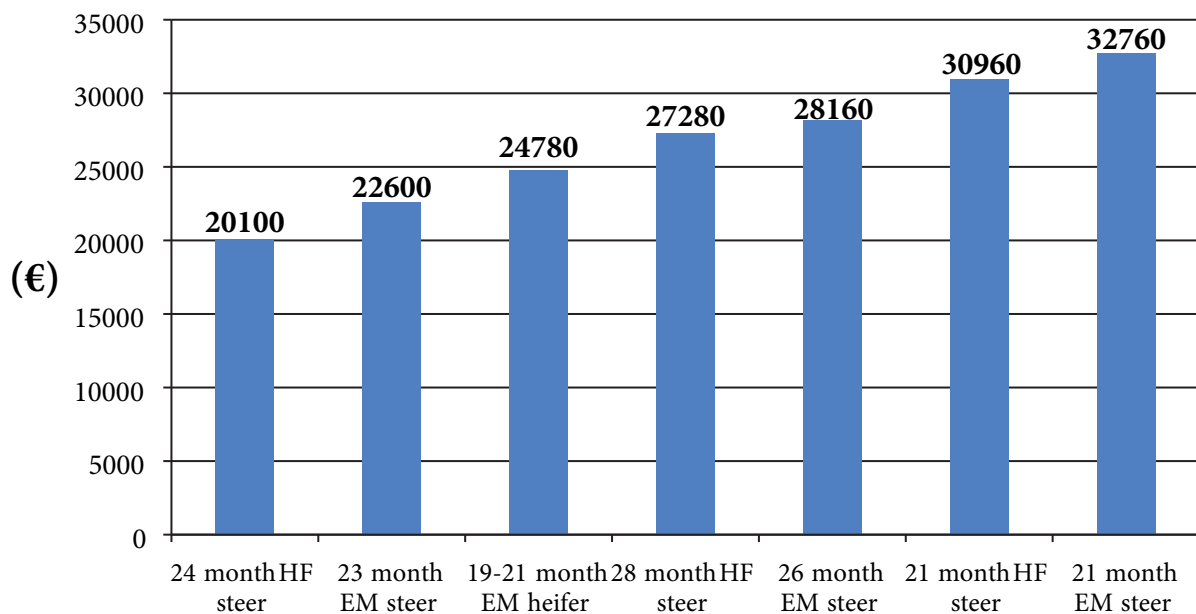


Figure 2: Net profit of dairy calf-to-beef production systems based on a 40 hectare model farm*.

*HF= Holstein-Friesian and EM= early maturing (Angus and Hereford dairy crossbred animals) and breed bonuses were included in the early maturing production systems.

Farm management and cash flow

From a farm management (utilisation of grazed grass and silage, availability of housing etc.) and cash flow perspective, beef producers normally operate more than one production system. It also ensures a number of sale dates throughout the year. Even with the most profitable production systems, operating a single system can be a challenge. For example, if a beef producer operates a 21-month steer production system grass demand in the spring is low because the yearlings will be approximately 320 kg at turnout and spring-born calves will have little demand for grazed grass until turnout in May/June. In addition, because these steers are slaughtered before the second winter the requirement for grass silage is significantly reduced. In this scenario having a proportion of steers carried through the second winter and slaughtered during their third season at pasture would complement the 21-month steer system. This would also result in a sale date for these animals that typically coincides with higher beef prices in June/July.

Herbage production

A key element of profitable dairy calf-to-beef systems is the efficient utilisation of grazed grass. Figure 3 highlights the variation in the feed budgets for grass, grass silage and concentrates for each production system. Each system has a different requirement for grass herbage per head ranging from 2.3 t DM for the 19-month heifer systems to 4.3 t DM for the 26-month steer system (Figure 3). At a stocking rate of 200 kg organic N per



hectare and assuming excellent levels of grass utilisation, the farm would need to grow between 10.1 t DM/ha and 11.6 t DM/ha for each system, respectively. At 225 kg organic N per hectare this rises to 11.3 and 13.0 t DM/ha, respectively. Thus, the capacity of the farm to grow grass will largely dictate the stock carrying potential of the farm.

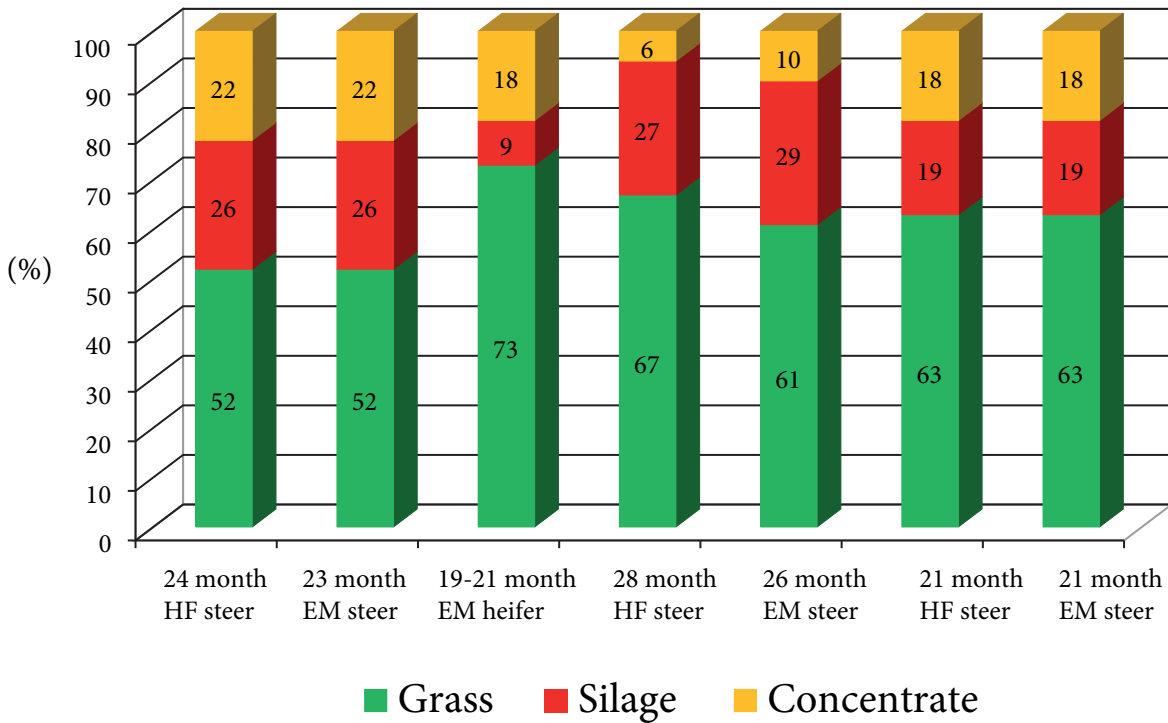


Figure 3: Feed budget for Holstein-Friesian (HF) and early-maturing (EM; Angus and Hereford) dairy beef crossbred production systems.

Conclusion

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

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Some practical factors affecting calf health in indoor calf rearing systems

Martin Kavanagh

MVB, Cert DHH, Cow Solutions, Dromline Road, Tipperary Town, Co. Tipperary, Ireland.

Summary

- Calf health is driven by the balance between their immune status and the burden of disease in their environment.
- A percentage of purchased calves will have unknown immune status and disease burdens
- Management input can solve many environment and feeding issues to enhance the immune system and reduce disease burdens.
- Calf environment is critical in maintaining healthy calves – fresh air with no draughts, dry bedding and floors, correct temperature for young calves.
- There are simple rules to follow which if implemented will get both old and new buildings working for you; it doesn't have to be expensive!
- Minimum 1.5 m² of floor space per calf up to 100 kg. A calf house should have a minimum cubic air capacity of 10 m³ per calf up to 90 kg. Air outlet areas should be a minimum of 0.05 m² per calf and situated 1.5- 2.5 m higher than the inlet. The inlet area should be 4 times (minimum 2 times) the outlet area per calf. In a ridged building, as a general rule of thumb, allow a minimum of 50 mm of ridge opening for every 3 m of building width.
- The farmer can easily spread disease with poor work and hygiene routines; this can be worked out in advance to prevent young calves catching disease from older or sick calves.

Introduction

The purpose of this presentation is to demonstrate some of the practical factors that can impact on the calf, causing stress, and contribute to the development of disease. By knowing these weak points or bottlenecks in your system you may avoid serious disease outbreaks and achieve the required growth rate of 700-800 grams per day efficiently.

Every sick day a calf experiences will slow its growth and add cost to finishing the animal. While the actual cost of treating a calf is significant, the lost opportunity in weight gain when the animal is at its most biologically efficient will add considerably to the overall loss incurred by calf disease.

The bought-in calf is a high risk animal. These calves are generally under three weeks of age and are dependent on the immunity they acquired from colostrum to prevent them picking up diseases. Calves at this age may have already had a disease episode or be a carrier of disease.

It is impossible to know the true immune status of these calves, unless they have been tested in the first week of life to check their protein levels, which indicates how much colostrum they received. Also, many of these calves will have been fed on 'waste' milk that may contain high levels of bacteria and mycoplasma, and may be of poor nutritional value.

Let's assume that a percentage of these purchased calves have weaker immunity, have had a poor nutritional start and already carry a disease burden when entering the farm. The risk is that these calves can begin or prolong an outbreak of more serious disease in the entire group if the management and/or environmental factors predispose the calves to succumb to infection.

The Farm System

All farm animal systems require four elements to work together to generate profitable performance; 1) the animals themselves, 2) the environment the animal lives in, 3) the feed and water which must be fit for purpose, and 4) the people involved must manage these elements to get the very most out of the system.



The Animal

The true health status of the bought-in calf is an unknown. Your experience in judging the physical appearance of the calf will guide you on its current state of health. The clarity of the eyes (no eye discharges, no sunken eyes), alert appearance, coat quality, clean tail and rear end, no navel swelling or discharge, moist clean nose, all help indicate a healthy calf. A useful test is the skin tent test to see the elasticity of the skin. If you pull the skin over the back or ribs and it immediately springs back to the body then the calf is well hydrated. On the other hand if the skin stands for a couple of seconds and is sluggish returning to the body then there is evidence of dehydration.

You can't know if the calf is a carrier of disease unless you have a comprehensive knowledge of the vendor's herd and you can't know the level or quality of colostrum received. The calf can only be judged on how it has presented on the day and the history of calves from that vendor. There is merit in considering routine monitoring for blood protein levels in the first week of life of all purchased calves, and calves meeting the target commanding a premium to cover the cost of testing.

Calf vaccination has an important role to play in providing the calf with immunity to the more common diseases, in particular the respiratory viruses and bacteria. A standard protocol of vaccination should be in place for bought in calves covering IBR, RSV, PI3 and pasteurilla species. Some vaccine programmes can be initiated before 2 weeks of age and it is worth considering beginning vaccine protocols on the vendor's farm where appropriate. There are no vaccines available commercially for mycoplasma species and it is worthwhile discussing testing or monitoring of vendor herds for this pathogen with your vet.

When the calves come to the farm they should get fed, rehydrated if necessary, and warmed up using lamps, deep straw or jackets.

Coccidiosis is often carried into the new environment by young calves or may be present from previous batches of calves. Routine treatments from 3 weeks of age and all-in all-out movement of batches, followed by disinfection, is necessary to control this parasite.

The environment

Calves must have fresh air, no draught (low air speed), a dry environment, and be within the correct temperature range to grow and maintain their immune system. The majority of calf housing, both old and new, is not fit for purpose. There is generally an imbalance in one or more of the four elements; not enough fresh air, too much draught, too wet and too cold. Irish weather conditions, particularly in springtime, are so variable and the temperature, wind speed, and humidity will often change hourly. Because of this there is, as such, no perfect shed but there are basic principles, which if followed, allow simple conversions of old sheds and improvements made in new ones that make them work. If you understand the needs of the calf at different stages of growth then it is possible to adapt sheds very easily to successful calf rearing environments.

(i) Temperature

Air speed has a direct impact on the temperature at which an animal has to burn additional energy to keep warm. This point is referred to as the Lower Critical Temperature (LCT). Up to two weeks of age the lower critical temperature (LCT) for the calf is 5°C. Below this temperature the calf is burning energy to both maintain its core temperature and its immune system. The optimal temperature for the calf is between 15 and 25°C. The LCT is affected by a number of factors including coat length, and whether the coat is wet or dry. As cattle grow and become heavier, their LCT reduces, enabling them to withstand lower temperatures without becoming stressed. Similarly, as growth rates increase LCTs tend to reduce.

For young calves up to three weeks of age, the optimum temperature is > 15°C. At temperatures below 10°C the calf will require extra feed to stay warm. For every 1°C drop in temp below 10°C, the calf should get 2% more feed in the form of extra milk or increased milk powder concentration.

Increasing the depth of the straw bedding, providing other heat sources such as red lamps or linear quartz lamps, and calf jackets, can all help improve the ambient temperature. If calves are sick they should have a warm sheltered area to get out of cold draughts.



Irish calf houses are made from materials with poor thermal properties such as concrete and tin, which do not hold the heat and act like a deep freeze in cold weather. During cold weather spells, calves under a month old need sheltered areas within large sheds to warm up in; these are micro-environments within a larger environment. This is the principle that igloos and hutches work on. The calf is sheltered in a micro-environment and the hutch can ventilate by the stack effect due to the heat generated by the calf. These systems fail if there is excess moisture due to poor drainage and wet bedding.

(ii) Fresh air & airspeed (draughts)

100% fresh air will kill bacteria and viruses 10 times quicker than 50% fresh air. Lack of fresh air increases survival time of airborne bacteria and viruses, concentration of toxic and noxious gases, and can reduce oxygen concentrations.

There is too little fresh air in most calf houses. A calf house should have a minimum cubic air capacity of 10 m³ per calf up to 100 kg. Often the solution is to create a large opening in the building that increases air speed but allows draughts to develop, creating more problems. Excessive air speed at calf height causes wind chill and should be avoided, particularly for young calves. This is because the increased speed of air around the calf reduces the insulation properties of its hair coat, thereby increasing the rate of heat loss from the body. If sustained or excessive, there will be a direct negative impact on productivity and immune competence. This is compounded if the calf or calf bed is wet. A one month old calf's LCT is 0°C, but if the airspeed is 2 m/s, the LCT is 9°C. A wind speed of 2 m/s will just make loose straw barely move and tremble. So, in a draught that we will barely feel, the calf is getting colder, more stressed and increasingly susceptible to pneumonia. Remember that the young calf is more at risk due to its LCT. As the calves age, they become more capable of withstanding the effects of draughts.

What is most important is to maintain the air quality around the calf. The calf spends more than 80% of its day lying down. The air change is needed approximately 25 cm above the bedding. Due to poor air exchange in calf pens, there is a buildup of ammonia at calf nose level that damages the natural defenses of the calf's airway.

In an indoor environment most problems are caused by insufficient outlet areas (minimum of 0.05 m² per calf) in the ridge or roof and insufficient inlet areas (need to be four times greater than the outlet area). Many of the modern cladding systems do not allow enough air in and buildings are smelly, dirty, warm and damp. Yorkshire boarding is an excellent solution or cladding with at least 25% void. In a ridged building, as a general rule of thumb, allow a minimum of 50mm of ridge opening for every 3m of building width.

Roof pitch has a major impact on airflow – the steeper the pitch the better – a pitch angle of 17-22% is recommended depending on the overall design and aspect of the building.


Ironically, in Ireland, due to the nature of the construction of sheds and the prevailing weather, the air inside is often colder than outside, leading to an air sink rather than an airflow outwards. This is compounded by poor outlet size and design for the class of animals in the shed. Cross ventilation is the easiest solution where the shed is narrow enough for air at slow speed to cross the house and exit the far side once there is sufficient inlet. Air can also be mechanically blown into the shed in order to push out the stale air; positive pressure ventilation by means of a fan and tube system. This system needs to be designed according to the dimensions of the building, fan size and speed and the position of the calf pens.

Mechanical ventilation can ventilate an existing building but always look to the simpler and cheaper solutions to improve the inlet and outlet dimensions. Fresh air is critical to control respiratory pathogens and good ventilation keeps the areas dry.

Mono pitch buildings that are too deep i.e. > 9m, will struggle to ventilate properly and it is common to see these buildings with poor drainage and inadequate inlet that prevents fresh air flow.

(iii) Moisture

Moisture is produced by all livestock in their breath, urine, faeces and sweat. Many calf houses retain moisture due to inadequate drainage, leaking water troughs, water and urine pooling in areas, excessive hosing and cleaning without good drainage, poor air change and drying, and condensation from non-insulated or tin roofs.



Excess moisture increases the risk of bacteria and virus survival, the risk of dirty water transmitting infection, the requirement for bedding and also reduces ambient temperatures. At all times the calf environment should be dry. Floors under straw need a 1:20 fall and pens should drain separately.

Straw can be expensive and, in many situations, under-utilized. Dry straw should cover the knees and hocks when the calf is lying down – this allows the calf to nest and maintain a microenvironment of 15°C around its body. It is not advised to use a straw blower when bedding calves under three months old as they have poor ability to trap and get rid of the dust particles from their airway. A calf will require approx. 200 kg of straw to bed it for a 25 week period under well drained conditions.

(iv) Space for calves and grouping

As a general rule calves up to 150kg should have a minimum 1.5 m² of floor space. A pen of young calves with this floor space will look understocked and there is a temptation to add calves. Calves should move in pairs and remain with calves of the same age (not more than a week difference in age from the youngest to the oldest). This prevents older calves infecting more susceptible younger calves. Increase group sizes by adding stable groups of calves, not adding individuals as this is highly stressful on the individual calf. Preferably, in bought-in calf environments, try to maintain the stability of groups and practice all in-all out stocking so pens can be cleaned after each batch.

(v) Hygiene

Calf health is a function of the calf's ability to fight infection and the burden of infection it encounters. While the calf's acquired immunity from colostrum may be out of the control of the buyer, but the environment the calf is in, the feeding regime and the vaccine protocol are all under the farmers control and will all help enhance the calf's immune system. The other side of the coin is hygiene and reducing the burden of infection from bacteria, parasites, and viruses. Hygiene in the environment is critical and most surfaces in calf houses are hard to clean well. The finish on a building, and the use of plastic partitions and pens, makes cleaning and disinfection much easier.

Good cleaning routines of calf feeding equipment, pens and beds reduce the infection burdens and each farm should have a standardised cleaning protocol worked out with their vet to reduce disease challenges. Also, the work routines on the farm should not spread disease; diseases can be contained to groups. The people working on the farm are the highest risk spreaders of disease. Foot dips between sheds will help but leggings are rarely cleaned and disinfected between groups. Manage your work routine where you first work with young calves, then move on to older calves and lastly deal with the sick calves. In other words you manage the most vulnerable and healthiest first before managing the rest.

Sick calves should be isolated, where practicable, from the main group. A group of sick calves should be kept together in a hospital area and not mixed back into groups of young calves in an effort to bring them on.

On no account should personnel from off-farm enter calf areas in non-disinfected leggings and boots. This includes vets, other farmers, calf buyers, etc. It is recommended that workers in calf rearing areas do not wear the same leggings and boots as they do when working with older animals.

Feed & Water

Routines for feeding dairy beef calves are well described and most systems can rear calves successfully. Increasing feed consumed during periods of environmental stress is important as scour and pneumonia outbreaks are more likely, when the ambient temperatures drop, due to moisture and wind chill.

Despite its importance and recognition as the most critical nutrient, water intake is often the weakest link on farms. Calves must be provided with additional water beyond what is consumed as part of the liquid milk diet. The development of starter dry feed intake depends on water intake. Fresh water should be available from week one. If the concentration of powder is increased due to cold stress then water must be available ad-lib as the overall dry matter intake is increased. Water intake does not cause scouring in calves; rather, calves that scour voluntarily increase their water consumption, if it is available. Water troughs should be cleaned daily, be sited off the ground and a rule of thumb is to have one trough or drinker per 10-12 calves.



Operating a profitable and sustainable calf-to-beef enterprise

Alan Kehoe

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Summary

- Returned home farm in 2012 and setup a 120 Friesian dairy calf-to-beef system.
- Emphasis on maximising animal performance at every stage.
- Calf health, environmental factors, animal housing and nutrition are my key focus in rearing a healthy calf to weaning.
- Grassland management is critical to maximise animal performance – put in place a system of paddocks and water troughs to take full advantage of grass to meet key weight targets at different times of the year.
- 3-year plan put in place with Teagasc adviser. This had clear targets for the numbers of calves purchased each year, target live-weights, stocking rate, output per ha and carcass weights. Planning is critical to hit targets and achieve a successful outcome.
- The system I have put in place has increased my gross output from -€98/ha in 2012 to €1,695 in 2015.

Introduction

I returned from Australia in 2012 and had to decide what farming system would best suit my farm. The farm had previously been used for breeding sports horses and there were no stock present. The farm consists of 54 ha of grassland, 6 ha of whole-crop barley and 10 ha of forestry. Soil type is quite good but it is overlying very wet marl. There is forestry planted on my farm and neighbouring farms so this will give you an indication of land type.

I previously worked on a dairy farm and reared calves, so after discussions with my Teagasc adviser, Martina Harrington, I decided to go down the dairy calf-to-beef route. I sat down with Martina and we drew up a 3-year plan to rear and finish 120 Friesian steers at 24-months of age. I now buy 60 calves in autumn and 60 in spring. The reason I have gone with both systems is because it spreads the work load and I will have sales in September and March which helps my cash flow. On average I pay €150 for a spring born calf and €170 for an autumn born calf and feel that the initial outlay in purchase costs is much lower than in a Hereford or Angus calf-to-beef system. The other main issue I have on this farm is housing, I currently have to rent sheds for my older cattle. All cattle are straw bedded, using in the region of 450 round bales of straw annually. I have a plan in place to build a slatted shed which will reduce straw and labour.

My aim is to produce Friesian steers at 24-months of age as cost-effectively as I can. To me there are three key factors in calf-to-beef production- calf price, performance of the animals and beef price. I can affect the price I am willing to pay for a calf, but more importantly I can affect the performance of the animal while on my farm through improved calf health and nutrition, better grassland management, weight gain from grass, and the provision of a cheap finishing diet by using top quality silage. I am always looking for the best possible beef price for my animals, but I know this is out of my control. I take responsibility for what I can influence and I am always looking for ways to improve my overall management skills. With this in mind Martina and I set down achievable targets in terms of weight gains, grass growth, weight for age and carcass weights in my 3-year plan. This has been invaluable for me as it has given me a clear pathway from when I started with 25 calves to where I am now rearing 120 per year.

Calf rearing

I source all the calves through an agent and this allows me to put more time into managing them as best I can rather than spending time in marts or on farms buying calves. I buy them together as a group which means

between the 1st and 15th October I will have 60 autumn born calves on the farm and again from the 1st to the 15th Feb I will have the 60 spring born calves bought in. I buy in a large group of 60 together so I can feed, treat and graze these animals as one in the first year.

The calves arrive on my farm on a Saturday morning and I let them rest until their first feed in the early evening. On arrival I vaccinate calves for viral pneumonia (RSV, PI3, pasteurella species) and IBR. I see this as a key factor in preventing problems and if a health issue does arise I find the treatment and recovery time is short. My calf rearing shed has been converted from a horse jumping arena. I put in a concrete floor and calf penning that can be removed after the calves are reared. I pen the calves into six groups of 10 along one side of the shed. Once they are weaned off milk and before the spring calves arrive they will be moved into three groups of 20 and housed on the opposite side of the shed. Last year I introduced a micro-climate, this is basically a lower roof in each pen that the calves can lie under. I bolted brackets to the wall and covered it with mesh wire. I then put straw on top of this wire. This allows the warmth of their body temperature to build around them and increase the temperature in the micro-climate leading to improved performance.



The milk replacer used is whey based with 20% crude protein. Calves are fed at the rate of 150 grams per litre and fed 2.5 litres of milk replacer twice a day. This is reduced to once a day feeding leading up to weaning. I introduce a calf starter ration on the first day and my target is to have calves eating 1.5kg of concentrate at weaning. I feed straw as their roughage and have a drinker with fresh, clean water in every pen. I make sure that the ration is kept fresh in front of the calves and top it up a number of times during the day. I always keep the straw bed as dry as possible and put in fresh straw as required. The calf rearing stage is critical on any farm and I put a lot of work and thought into how I can successfully rear calves as efficiently as possible with minimal losses. I had thought about going down the automatic feeder route but when doing some research came across two very helpful labour saving devices. The first is a gas powered water heater which I have set up in the calf shed. It is built on the same principle as a shower that is you pipe in cold water and when you light the gas you have a constant flow of hot water to use for mixing milk powder. This simple and inexpensive system only needs a cold water pipe into it and a small bottle of gas. The second invaluable piece of equipment is the milk cart which I purchased last year. I pump the hot water into the milk cart, add milk powder and in less than a minute it is mixed. I can pull this milk cart to whichever pen I am feeding and start pumping the milk into the teat bars for feeding. There is also a meter on the milk pump which tells me how many litres have gone into the teat bar.



This allows me to feed exactly 25 litres per pen (2.5 litres for 10 calves) and, therefore, calves are not over or under fed. These 2 pieces of equipment allow me to feed 60 calves in less than 45 minutes with the minimum amount of heavy labour. I can use the extra time to check on the health of my calves and other stock. I have continued also to use the teat bars to feed calves because in the morning if I go to feed and a calf does not come up for milk, I know I have a problem. I try to keep hygiene standards very high in the calf shed because I know that with the large number of calves housed together bacteria and disease is often a problem. This is why I wash out and disinfect the teat bars after each feed and leave them to dry before using again that evening.



Figure 1 - Water heater and milk cart

I aim to have the autumn born calves weaned before Christmas and the spring born calves are weaned at 10 weeks of age. I vaccinate for clostridia when going to grass and fortunately, up to now, have had no problems with coccidiosis.

Calf scour has never been a problem for me but this spring I had a major problem with viral pneumonia in the autumn born calves. It broke out in a group of weaned calves that were in the corner pen in the shed. The calves had been vaccinated and I believe now that the problem was lack of ventilation in the shed. The shed itself has sheeting from the eaves to the top of the wall with a few inlets cut out. I now have to increase inlet area on the shed to let in fresh air and I may do this by using Yorkshire boards or space boarding. Having had the problem last year I am going to sit down with my vet before calves come onto the farm this autumn and draw up a herd health plan. I had considered it previously but I now see that this is very important if I want to have all the environmental factors correct to get the maximum performance at the calf rearing stage.

Grassland management and animal performance

When I returned to the farm in 2012 there were a small number of paddocks in place on the farm and no reseeding had been carried out. I had decided that whatever beef system was going to be put in place that grass would be the driver of weight gain. With this in mind I set about splitting some larger field into paddocks and putting in water troughs. This was gradually done over a number of years and now I have the whole farm setup with paddocks. My father had put in roadways for the horses and I find these are invaluable when moving stock, spreading farmyard manure or fertiliser.

I graze the calves in two groups of 60 and this works quite well for me. Calves in their first year have a low demand for grass, I try and keep the best quality in front of them at all times. Most farmers with Friesian calves

will feed 1 kg of concentrate at grass for the summer months – I do not. I believe that if I can keep my calves on fresh grass every two days and they are hitting their weight gain targets that concentrate is not required. I currently weigh all my stock 3 times a year and have recently started to put these weights up on the Irish Cattle Breeding Federation (ICBF) website. Weighing the cattle allows me to see if they are performing and more importantly identify underperforming animals. Currently the 2015 autumn born calves are averaging 261kgs (0.71 kg ADG since birth) and the 2016 spring born calves average 217kgs with a target of 230kgs going into the shed for the first winter. I am hitting the target live-weight gains and would be very hesitant to feed the 1 kg of meal to calves all summer as I have to keep production costs to a minimum.

Last winter the weanling/yearling calves were fed 1 kg of concentrate and 75% DMD silage and performance was on target. This year I have whole-crop barley which I will feed with silage to the stores and finishing animals. I will use a protein source to bring up the crude protein value for the store cattle.

I currently have a finishing group of 48 Friesian steers born in autumn 2014 which I have just started feeding 3 kg of concentrate while at grass. These animals went to grass on the 18th March weighing 418kgs. I weighed them again on the 23rd July and they weighed 545kgs. Their average daily gain was just over 1 kg on grass only. These steers will be finished at grass and will not go back into the shed. All the stock going to grass for the second season are given 3 days in a paddock and then moved. I put the steers in groups of 30 to 40 and this works very well for me.

In 2015 with the help of Martina Harrington I started measuring grass on the farm. I wanted to know how much grass I could produce and was there potential for me to increase calf numbers. On average in 2015 each paddock grew 8 tDM/ha. Nationally dry-stock farmers are growing 6 t DM/ha and I know I can improve by continuing to improve soil fertility, increasing the amount of nitrogen spread and continuing the reseeding programme on the farm. However, this all costs money and over the last few years my priority has been to build cattle numbers. My plan for 2017, when I will have over 240 cattle on the farm, is to put more emphasis on soil fertility. Over the last few years while building cattle numbers I did not need as much grass but next year I will have to be able to meet the demand for the 240 head. I have found that measuring grass gives me confidence to make decisions on when to spread fertiliser or take out paddocks with surplus grass as bales. This summer I have taken out over 150 bales from paddocks and this is a clear indicator that my farm can carry more stock if the grassland is managed correctly.

Financial performance and future plans

Since returning home my biggest problem has been trying to build up cattle numbers on the farm. The two main factors affecting any young farmer is the initial cost of buying stock and in my case animal housing had to be taken into account. I have steadily increased the calf numbers and last autumn/spring was the first year to rear 120 calves. I will buy another 120 this autumn/spring but I won't see the full sales beginning until autumn of 2017.

I complete a Teagasc e-profit monitor every year and this allows me to evaluate the profitability of the system on my farm. The main two drivers of profit in this type of system are stocking rate and output. I aim to increase both of these until I hit full production while maximising efficiency and animal performance. I can slaughter 120 cattle a year but if I cannot keep concentrate costs and other variable costs to an acceptable level my potential gross margin will be reduced significantly.

Table 1 – Multiple year profit monitor results

	Stocking rate	Gross Output	Variable costs	Gross margin
Year	LU/ha	€/ha		
2015	1.88	1,695	1,299	396
2014	1.05	1,085	1,231	-147
2013	1.04	780	604	177
2012	0.34	-98	494	-592



Table 1 outlines the key figures from my last four years of profit monitors. Stocking rate in 2015 was 1.88 LU per ha and I had a gross output was €1,695 per ha. This is clearly showing that as I increase the stocking rate my output is increasing. Variable costs are running at €1,299/ha which are high. This reflects the reseeding, fertiliser and lime costs of setting up the farm. I have re-seeded the majority of the farm over the last 4 years and spread 2.5 ton of lime to the acre. My aim at full production is to carry 2.5 animals per ha and have a gross output of €2,600 per ha. Variable costs will be typically 50% of gross output which is €1,300/ha leaving a potential gross margin of €1,300/ha. I believe this is achievable on the farm but I know I have to keep my variable costs at current levels. This will be a challenge for me but I know I have been steadily making progress going from a gross margin of minus€592/ha in 2012 to €396 in 2015.

Housing on the farm is limiting at the moment. I have rented a slatted shed for all my yearling stock but have plans to build a slatted shed. I have applied for grant aid from the Department of Agriculture, Food and the Marine to build an 8 bay slatted shed and I am currently awaiting approval. I am building this in the home yard and this will reduce the time and labour spent feeding and bedding cattle.

When I get the shed complete and cattle numbers up I will reassess the whole farm plan. I may continue to increase calf numbers but I will wait and see. My main focus now is to produce the 24-month Friesian steer beef as efficiently and profitably as possible by maximising the amount of grass in their diet.



French beef cattle performance recording scheme, impacts and prospects with genomics for the beef industry

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Summary

- France has developed genetic programs to improve beef cattle with the aim of achieving a more profitable beef industry.
- The beef cattle performance recording scheme developed in France has facilitated the development of a very useful genetic evaluation system called IBOVAL.
- The performance recording scheme is also useful for developing the advice provided to farmers.
- Thanks to this performance recording scheme, French livestock have made genetic progress in increased animal size and weight. This change was financially advantageous for the production of cull cows.
- With the development of the genomic evaluations and changes in the beef industry, French producers must redefine the breeding goals and develop new collections of useful phenotypes.

Introduction and context

France is a major beef producer, ranking first in Europe and one of the top ten producers in the world. With more than 4.09 million cows in 2015 (Institut de l'Élevage Geb, 2015), the French herd is by far the largest in Europe and includes some specialised (Charolais, Limousin...) and hardy (Salers, Aubrac...) breeds.

French beef is somewhat unusual in that much of it is produced from pure breeds, and a high percentage is produced with cow carcasses. Veal meat is also important. Each year, about 1 million weaned calves are exported to foreign fattening farms (Italian, Spanish...).

About 94,000 farms own more than 5 suckler cows (Institut de l'Élevage Geb, 2015) and there is a strong tendency toward bigger farm sizes. As of today, 30% of farms have more than 50 cows and these represent 62% of the total of suckler cows.

France developed high-performance programs and genetic evaluations on-farms (named IBOVAL) for nine beef breeds. For the main specialised breeds (Charolais, Limousin and Blonde d'Aquitaine) on-farm and on-station evaluation of young bulls are completed by progeny testing for maternal traits and meat traits. For the other breeds only on-farm and on-station evaluation of young bulls are made.

The beef recording scheme is composed of a large population (986,000 cows) followed by a parentage recording system. About 60 performance recording organisations collect weaning weights and linear scorings on 350,000 calves (Guerrier J., Leudet O., 2015). The best males, born from planned matings are identified on farm with all recorded traits, are selected after weaning using individual on-station testing (more than 2,300 bulls evaluated per year) and for some future AI bulls and some breeds, using progeny testing on maternal qualities and fattening abilities. The selection criteria are chosen according to their economic importance, their importance for all breeding societies, and the easiness of data collection. A common database (SIG) is used to gather such data.

The aim of this paper is to present the French beef cattle performance recording scheme, its impacts on cattle breeding, future prospects with genomics and the direction of the beef industry.



The French beef cattle performance recording scheme

Firstly, France has a large parentage recording system with about 4.16 million calves born in the beef and dairy herds having a certified parentage (personal source, 2015). More than 56% of the calves born are enrolled in these data recordings. It is managed by 61 local livestock organisations (called EdE in France) which are also in charge of identification and traceability in France. Beef cattle represent 24% of the calves having a certified parentage (996,000 calves born in 2015) and accounts for about 21,000 farms with beef cattle (Figure 1).

All the information collected at birth includes:

- birth condition score (or calving ease score): 1 (unassisted calving), 2 (easy pull, assisted by one person without mechanical assistance), 3 (hard pull, assisted by more than 1 person or a veterinary surgeon or a mechanical assistance), 4 (caesarean), 5 (embryotomy),
- birth weight (in kg) and any information about the measure (weighed or not),
- chest girth (in cm),
- embryo transfer (yes or no),
- twin (yes or no),
- abortion (yes or no).

The birth condition score, birth weight and chest girth are used in the calculating IBOVAL to give two breeding values (EBV's):

- calving ability (A_{Vel}) and
- ease of birth (IFNAIS).

Two other EBV's are also calculated using the recordings of calving's and artificial insemination (AI):

- EBV of AI success on heifers (RIAP_{gef}) and
- EBV of the productive life (EFCAR).

The last one is calculated with the number of calving's at 78 months of age.

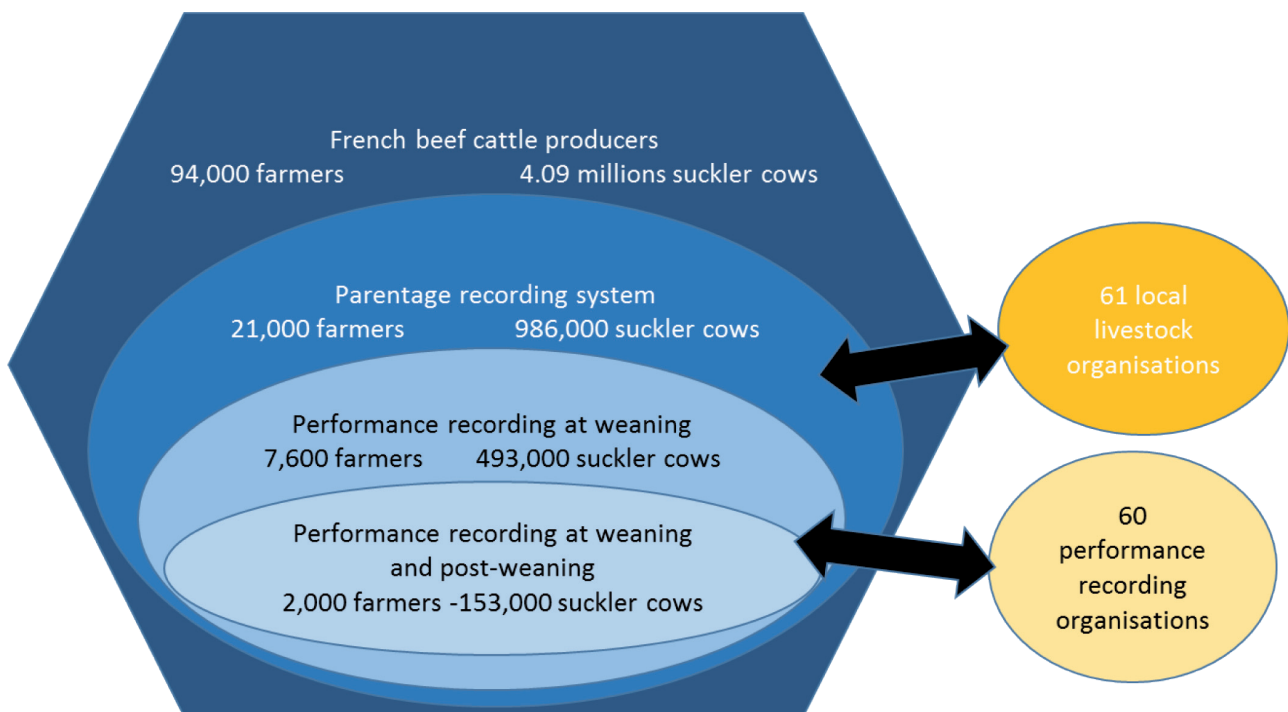


Figure 1. French performance recording scheme in beef cattle (2015)

Secondly, the farmers which are members of the parentage recording system can join the performance recording scheme at different levels and work with the 60 performance recording organisations called Bovins Croissance (figure 1), the levels are:

- First level: recording of weaning traits and advice (about 7,600 farmers),
- Second level: recording of weaning and post-weaning traits and advice (about 2,000 farmers).

For the weaning traits, data are collected on different weights, linear scoring, two docility scores and some information about the breeding system is also collected. The farmers can choose to weigh the calves themselves or to ask an organisation for help with this. All collected performance data are validated and put in the database by the performance recording organisations.

For the weaning gain, the aim is to obtain an adjusted weight at 210 days (P210) and to achieve this, each calf is weighed twice before the age of 300 days. A second adjusted weight can be calculated, it's the adjusted weight at 120 days (P120). These performances are used to calculate IBOVAL EBV's for:

- (i) weaning growth capacity (CRsev) and
- (ii) milking ability (ALait).

For the linear scoring at weaning, 19 traits are scored individually on a scale from 1 to 10, using the official definition of ICAR (ICAR, 2016) to describe the morphology of the animal:

- 8 frame traits: back length, length of rump, height at withers, width at hips, chest width, thurl width, chest depth and thickness of bone.
 - o The first four are used to build the skeletal development traits (DS) which is evaluated in IBOVAL (EBV: DSsev).
 - o While the thickness of bone is used to publish the bone slimness EBV (FOSsev).
- 6 muscularity traits: muscularity shoulder top view, back width, thickness of loin; thigh rounding side view, thigh width rear view, thigh length. The first five are used to build the muscular development trait (DM) which is evaluated in IBOVAL (EBV: DMsev).
- The body condition score.
- 4 functional traits or type traits: muzzle width, top line, a global score for rear legs and a global score for front legs. These traits are used to calculate the functional abilities trait (AF).

Two total merit indexes combine the weaning traits:

- (i) total merit index for direct effect at weaning ISEVR and
- (ii) total merit index for direct and maternal effect at weaning IVMAT.

Since 2012, France is collecting two new traits relating to the docility of the calves at weaning:

- (i) behaviour of the calves towards the person undertaking the linear scoring, and
- (ii) behaviour of the calves in the weighing scale.

The first trait is a linear scoring from 1 to 7 (Table 1) and it is used to calculate IBOVAL EBV: a behaviour at weaning linear scoring (COMPsev). While the second is a count of the number of movements in the weighing scale (from 0 to 10 +) and it is used to calculate IBOVAL EBV: a behaviour during weighing (REACsev) score.

Table 1. Scores of behaviour of the calves towards the man

	1	2	3	4	5	6	7
calf	comes to	is still	walks	walks quickly	runs	threatens to attack	attacks

Some farms choose the second approach and also collect data for post-weaning traits. In 2015, about 2,000 farms agreed to weigh their heifers each year. The goal is to obtain an adjusted weight at 24-months (P24M) for the females that have their first calving at 36-months or an adjusted weight at 18-months (P18M) for the other females (first calving at 24-months). An effort is made to try to calculate an adjusted weight at 12-months (P12M) for all heifers. All adjusted weights are used to estimate the IBOVAL EBV: the post-weaning growth capacity (CRpsf).

Farmers can also be members of breed societies. For these, the breed societies plan to collect post-weaning linear scoring on heifers. The aim is to score the heifers at about 30-months old (first calving at 36-months). All heifers must be scored between 18- (first calving at 24-months) and 42-months and if possible to score the heifer after first calving and during the 6 months period after calving. The traits are globally the same as at weaning. Some new traits are scored like the rump angle and the flank depth. The estimates DM, DS, AF are calculated with the classical traits like at weaning. Some news estimates are also calculated like:



- the rump size and shape (called BAS) only for Limousin,
- the breed qualities (QR) only for Rouge des Prés (i.e. Maine Anjou),
- and the standard conformity (CS) only for Charolais.

These measurements (DM, DS, AF, rump, QR and CS) are used to estimate IBOVAL EBV's: respectively DMpsf, DSpsf, AFpsf, BASpsf, QRpsf and CSpsf.

Table 2, shows the number of animals involved in performance recording scheme in France. The Charolais and Limousin breeds represent a large proportion of the recording animals (about 75% of the weighed animals).

Table 2. Number of animals (calves or heifers) with recorded performances in France

Number of animals		Campaigns of birth					
		2012			2015		
Sex	Performance*	All breeds	Charolais	Limousin	All breeds	Charolais	Limousin
Female	Birth weight	460,064	178,514	116,048	484,799	184,821	125,421
	Chest girth				84,307	36,180	19,243
	P120	200,810	94,549	58,020	194,960	89,414	57,891
	P210	190,589	91,673	55,272	179,389	84,625	53,159
	Linear scoring at weaning	198,322	94,334	55,517	198,244	92,728	57,442
	P12M	62,681	39,279	12,415			
	P18M	37,186	27,215	4,854			
	P24M	25,192	20,607	2,216			
Male	Birth weight	476,502	186,963	117,931	501,342	192,449	128,994
	Chest girth				87,480	37,439	20,228
	P120	201,829	96,547	57,218	193,448	89,975	57,166
	P210	187,703	93,146	53,414	170,360	83,351	50,195
	Linear scoring at weaning	193,483	94,653	52,975	189,631	90,057	54,672

* P120 = adjusted weight at 120 days; P210 = adjusted weight at 210 days; P12M = adjusted weight at 12 months; P18M = adjusted weight at 18 months; P24M = adjusted weight at 24 months

To complete the national recording scheme, some young bulls (2,534 in 2015), from the nine main breeds, are chosen after weaning to be tested. The post-weaning growth capacity, the morphology (DM, DS...), the pelvic opening, and sometimes the feed efficiency of these young bulls, are recorded by breeding organisations. The feed efficiency is only measured in the AI company station to select the young bulls to become the future AI sires (267 young bulls were evaluated in 2015). Some additional bulls are selected during a progeny testing and in 2015 this involved three breeds in:

- Gènes Diffusion and Charolais Univers, the two AI companies involving the Charolais breed which evaluated 32 bulls on farm with the IBOVAL evaluation,
- Crealim, the AI company of the Limousin breed, evaluated 7 bulls in the progeny testing station of Moussours with specific evaluation, and
- Auriva Elevage, the AI company of the Blonde d'Aquitaine breed, evaluated 9 bulls in the progeny testing station of Casteljaloux with specific evaluation.

Finally, the last data used in the genetic evaluation are the carcass traits collected by the slaughterhouses. These data are managed by NORMABEV which provides data two times per year to the IBOVAL genetic evaluation. Using the data coming from the slaughters for the pure breed young bulls, France publishes the carcass EBV's for young bull production:

- carcass growth (ICRCjbf) and
- carcass conformation (CONFjbf).

With the data coming from the slaughters for the crossbred veal animals (with a beef cattle sire), the carcass EBV for the veal production: carcass growth (ICRCvbf), carcass conformation (CONFvbf) and meat colour (COULvbf) is generated.

An umbrella organisation, France Génétique Elevage (FGE), the national value chain organisation for the genetic improvement of ruminants, oversees the organisations which work on this scheme (local livestock organisations, performance recording organisations, AI companies, breed societies, Institut de l’Elevage and INRA).

Interest in the recording of genetic improvement and efficiency of the suckler herds

The French beef cattle high-performance programs would not exist without the large on farm performance recording scheme. The development of the recording scheme facilitated the development of the IBOVAL evaluation. The reliability of the “classical” produced EBV (without genomic information) depends on the number of records taken in the genetic evaluation. Figure 2 shows the evolution of the reliability of a cow’s EBV like easy birth (IFNAIS). A precise EBV is possible with the addition of the progeny performances. It is very important to have an extensive recording of the performance on the farms. Without these, we can have biased evaluations.

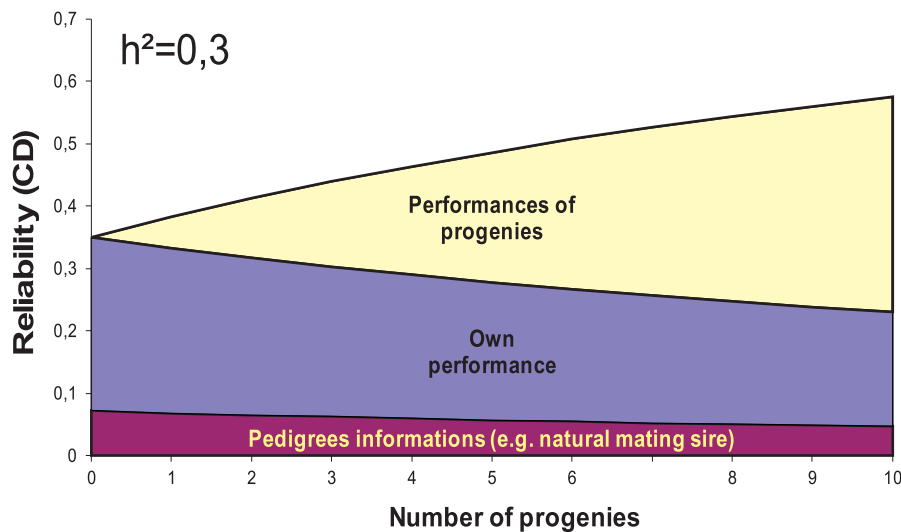


Figure 2. Reliability of a cow’s EBV during its productive life, e.g. easy birth (IFNAIS)

With the arrival of genomics, the interest of the recording scheme has remained the same. The genomic predictions need data from the reference population to estimate the genomic equations. And if accuracy is not to be lost, the performance recording scheme must be maintained every year to renew the reference population (Sonesson AK, Meuwissen TH., 2009).

The performance recording scheme brings a lot of technical data to the performance recording organisations. All statistics about reproduction, growth, and productivity are produced (Institut de l’Elevage, Bovins Croissance, Inosys réseau d’élevage, 2015). These technical references are very useful to help compare farmers and groups of farmers with the same breed and system. This data allows France to give breeding advice to farmers. Indeed some farmers are members of the performance recording organisations especially to get this advice.

Impact of the French genetic scheme

The impact can be measured in two ways:

- firstly, is the measure of the genetic progress inside the genetic scheme, and
- secondly, is the measure of dissemination or spread of the genetic progress to the wider industry.

Firstly, Figure 3 shows the genetic trends in the Limousin breed. Over the past 30 years, skeletal development and growth capacity were the priorities and the resulting genetic progress for these traits can be clearly seen. A smaller progress is visible for the muscular development and the calving ability. Because of the links between



traits, the easy birth (IFNAIS) and bone slimness (FOSsev) traits have been decreasing each year. So, in the Limousin breed (and also Charolais and Blonde d'Aquitaine breeds), the major impacts of the genetic scheme are to increase the size and the weight of animals and reduce the ease of calving.

Secondly, in relation to the dissemination or spread of the wider genetic progress created by the genetic scheme, we can see that in 2015 that 77% of the calves born had an improved sire (AI or natural mating sire) coming from the national recording scheme (Figure 4). The larger part of the change is due to the natural mating while AI represents a smaller part (12% of born calves). In the Charolais breed, AI is a little better (14%) and the impact of the recording scheme is about 80%.

In conclusion, the national recording scheme creates some genetic progress (especially size and weight of the animals) and its impact has spread to almost all French herds.

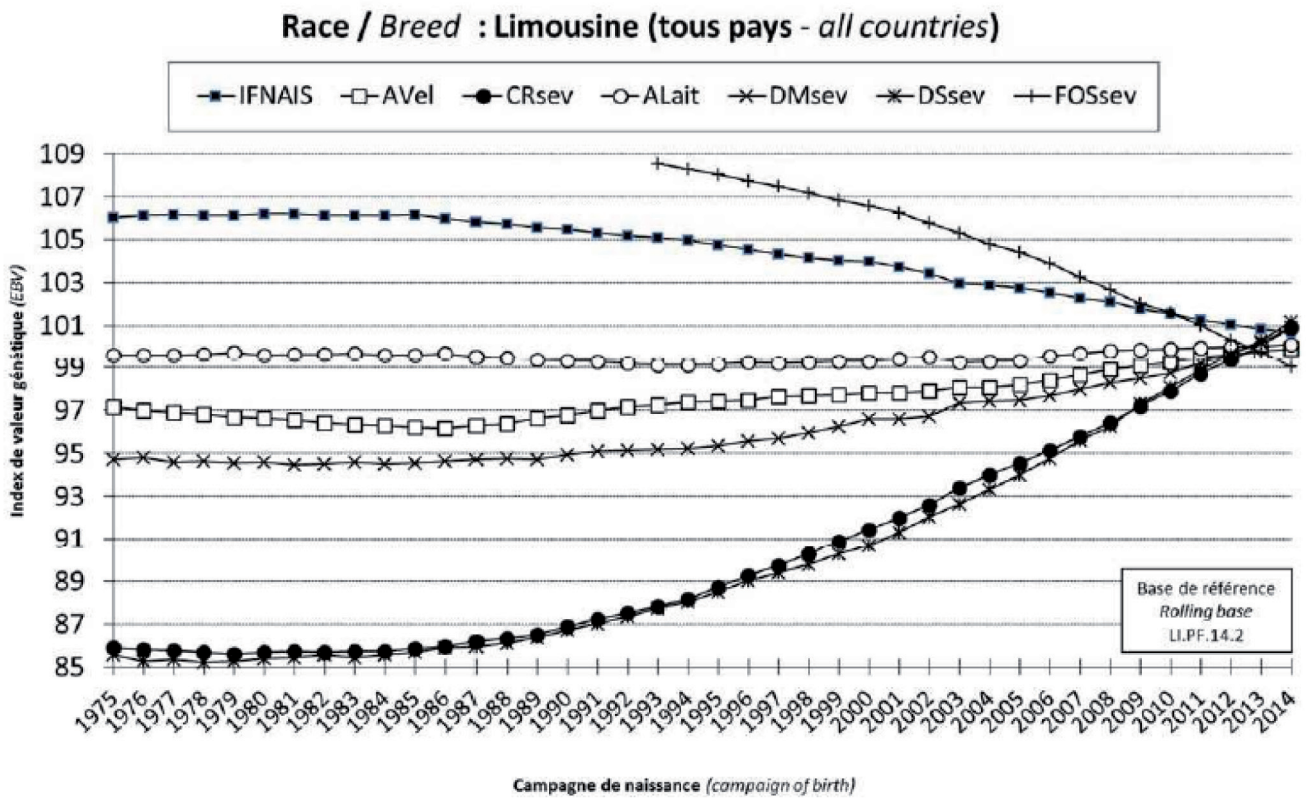


Figure 3. Genetic trends of the Limousine breed for the weaning traits

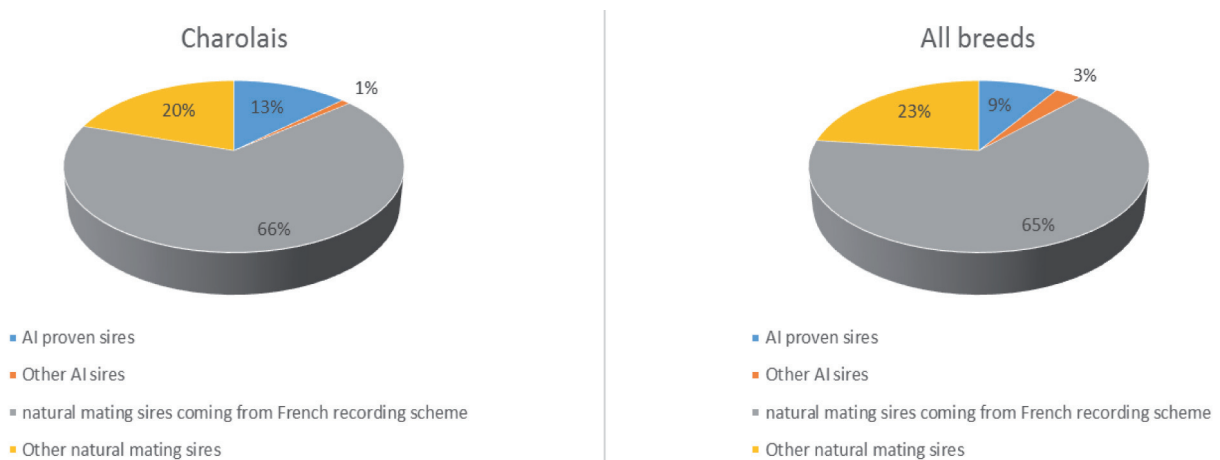


Figure 4. Percentage of born calves by type of sires for the Charolais breed and all breeds



Prospects with genomics

Since 2015, France has deployed genomic evaluations for the 3 main beef cattle breeds, the Charolais, Limousin and Blonde d'Aquitaine. The Illumina EuroG10K chip and 50K chip are used to estimate the direct genomic value (DGV) of genotyped animals. France uses a two steps method like the new Irish genomic evaluation in beef cattle. For the animals that have recorded performances, the DGV and the IBOVAL EBV are blended to give a genomic estimated breeding values (GEBV), and these animals are most of the time ranked between 70 and 130 (like the IBOVAL EBV) and published with their reliability. For the other animals, without recorded performance (no IBOVAL EBV), they only get the DGV and the animals are ranked between 1 star and 5 stars (* to *****), without reliability.

To have genomic prediction there is a need to have a sufficiently large reference population. This reference population is composed of all animals which are genotyped and have accurate EBV. Now, with the available reference populations, France is able to publish GEBV for the;

- birth traits IFNAIS and AVel,
- weaning traits (CRsev, DMsev, DSsev, FOSsev, ALait except the docility),
- carcass traits for young bull production (ICRCjbf, CONFjbf), and,
- total merit indexes ISEVR, IVMAT and IABjbf.

At the moment, the gain in reliability depends of the trait and varies between 8% and 80 % for a Charolais calf (personal sources, IBOVAL 2016_02).

The future prospects with genomics are:

- develop new collections of phenotypes,
- develop genomic predictions for the other breeds,
- changes in the genetic schemes and the expected increase of genetic progress

Before having accurate genetic evaluations for a group of animals, the performances of all these animals needs to be collected. France has already developed a large recording scheme and now, it can start to collect new phenotypes on a group of “reference” farms, So now genomics can allow France to estimate the breeding values for a large group of genotyped animals with this group of reference farms. But these reference farms need to have genetic links with the global selected population. In the DEGERAM project, some breed societies (France Limousin Sélection, Charolais France, UPRA Aubrac and Groupe Salers Evolution) worked with a group of farms to collect new phenotypes around the calving period. These farms collected new traits like the calf vigour, the calf health, etc.. The AI company, Gènes Diffusion, works with a group of farms collecting new phenotypes like the maternal instinct, the functionality of teats. With this, Gènes Diffusion offers some private genomic scores to their breeders. The genomics approach is especially interesting for the traits which are difficult to measure like the pelvic opening measurement (good predictor of the calving ability) and feed efficiency.

In the future, France hopes to be able to publish genomic breeding values for the other beef breeds such as Parthenaise, Aubrac, Salers. But for now are not able to estimate genomic breeding values for these breeds with a within- or an across-breed genomic prediction. Farmers are now waiting for the increase of the reference populations and the development of new methods (using of whole-genome sequence, single step...).

Finally, one of the major future prospects is the ending of the progeny testing of beef cattle in France. Since the end of 2015, the Charolais AI companies have already decided to stop their on-farm progeny testing and now choose their AI bulls only with genomic breeding values (official IBOVAL GEBV and private genomic scores). Other breeds have not yet stopped their on-station progeny testing.

Future direction of the beef industry

As mentioned before, French cattle breeding has increased the size and the weight of the beef cattle. Having a big cull cow is still often financially attractive because the heavy carcass is valuable. But some sections of the beef industry are beginning to change the payment for heavy carcasses and want to penalise poorly conformed heavy (>480 kg) carcasses. So now French farmers are starting to discuss a redefinition of breeding goals such as to stop the increase in carcass weights. Other aims of farmers and the beef industry are to:

1. produce an easy cow: easy calving, milking ability, maternal instinct, behaviour towards the man,



2. increase the productivity of cows: sexual precocity, stillbirth, mortality, and
3. reduce the slaughter age of young bulls.

On the first point, France already has methods for selecting for these traits except for the maternal instinct trait where it is only available for the Charolais breed. For the second point, France aims to develop a genetic evaluation of the mortality of calves, and for the third point, can use the EBV ICRCjbf (growth capacity of carcass for young bull production) index.

Finally, the breeding programme needs to work on the sexual precocity and the control of the carcass weight of cows. So now, a new project is being designed to work on animal growth curve and precocity. The aims are to control birth weight, mature body weight, to increase growth capacity at the early age (weaning and post weaning) and to allow the management of suckler herds such that they can calve at 2 years old. To achieve these aims there may need to be a redefining of the guidelines on the performance recording at weaning.

Conclusion

Thanks to a large performance recording scheme, France has developed an effective genetic evaluation of beef cattle (IBOVAL). This involves on-farm evaluation facilitates and genetic programs of nine breeds. First of all, France is able to evaluate a large number of animals, using a classical genetic evaluation programme and is now able to develop genomic evaluations. Maintaining the recording scheme will allow an increase in the accuracy of genomic predictions. The challenges for the future will be to continue collecting the performances of beef cattle and to provide direction to the farmers and the beef industry, thanks to the development of new genetic tools. This will be more successful as long as the genetic gains will be used and implemented at farm and industry level.

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How the accurate recording of birth weights, weaning weights and other data have helped me to make more informed breeding decisions

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Summary

- I have clear objectives for my suckler herd with a defined calving and breeding season
- I am recording data at calving, breeding, and scanning of my cows along with offspring data at weaning and at slaughter
- This information is driving the Replacement Index of my herd and helping me make better breeding decisions.

Introduction

I run a sheep and beef suckling enterprise on a 76 ha farm close to Thurles Town in Co. Tipperary. Land type is generally free draining and is in one farming block. The farming system is a 250 mid-season ewe - flock and 57 spring calving sucklers selling progeny as a mix of forward stores / finished beef.

I have always had a keen interest in gathering information on my suckler herd with the objective of making better breeding decisions. The main objectives for my cows are:

- They need to be functional cows. They need to be robust enough to fit my farm system. They need to calve easily, have good feet and udders. Lame/old cows are the first on my cull list
- They need to produce a calf every year. Empty cows, even “good cows”, are shown the door if not in calf after a 12 week breeding season.
- They need to produce a heavy, valuable weanling. This means having milk in the cows and having the genetic potential to drive growth and conformation.

My ideal suckler cow is a cross-bred cow; I am not breed-specific providing the cow meets the above criteria. My herd is mostly made up of continental-cross cows, e.g. Aubrac, Aberdeen Angus, Saler, and Simmental. I use maternal AI (primarily from the ICBF GENE IRELAND programme) for the first 6 weeks of the breeding programme to produce high quality replacements. I will use bulls from any of the beef breeds provided they have high performance figures. Because I am a big user of AI I believe in recording as much accurate information as possible on the offspring of these AI bulls. This will increase the reliability figures on these bulls much more quickly.

So where does the data come in?

There is a saying that knowledge is power and I start collecting data before the calf is even born!

All AI serve and stock bull data is recorded for the breeding season (first six weeks AI, further six weeks with a stock bull). This allows me to accurately analyse gestation lengths as I know exactly when the cow became pregnant. The next key piece of information that I gather is from scanning in August. I already have a good idea of which cows I am going to cull based on functionality and temperament and I add empty cows to the list.

The next key pieces of information I collect are calving difficulty scores (1-4) and calf birth weights. I always ensure to record the correct calving difficulty score. For practicality the weighing scales is placed in the calving shed, beside the calving pens, for ease of access. All weights are recorded using the animal events “pocket” notebook, which I also use to record all other birth information including date of birth, sex, dam and sire



details of the calf and the calf's tag number. I have a student to help me at calving time and weighing is part of the routine so this ensures that every calf is weighed. Because I am consistently weighing calves I can ascertain as to whether there is a pattern of certain cows always producing calves with heavy birth weights, or whether it is sire related. Generally heavier calves mean more calving difficulty. Interestingly enough, I have also linked lame cows in late pregnancy to heavier calves at birth. Recording calf weight also means I have an accurate starting point for live-weight average daily gain (ADG) to weaning.

All calves are weighed at weaning which feeds into the Replacement Index and milk figures for my cows. I weigh at slaughter and this gives me an accurate kill out %.

I then need to ensure that all of this data makes it to the ICBF database to ensure that the performance of my stock is reflected in the Euro-Star Indexes. I record calf births online through www.agfood.ie. The extra birth data such as calf weights and calf vigour is recorded on the ICBF website. Weaning weights are generally recorded by an ICBF weighing technician and these weights are recorded through a handheld.

So how has the data helped me?

Data is useless unless it is put to use. Using the information that is available to me and implementing a strict breeding and culling policy means I have a very functional herd. I am meeting my target of a calf per cow per year and the calving interval for the herd is 361 days. My calving statistics are outlined Table 1 below.


Table 1 – Beef Calving Statistics 2015-2016

Beef Calving Statistics 2015/2016		
Key Performance Indicators (KPI'S)	My Herd's Performance	National Average
Calving Interval (days)	361	399
Mortality – dead at birth (%)	1.4	4.9
Mortality – dead at 28 days (%)	7.2	6.4
Calves / cow / year	1.06	0.83
% of Heifers calved 22-26 months of age	79%	20%
Cows culled in period	15%	18%
Recycled Cows	2%	19%
Average no. calvings / cow	4.6	4.5
Births with known sires	100%	69%
Births with difficult calvings(%)	13%	3.3%
AI bred calves(%)	74%	24%

The information I have on my cows allows me to make more confident informed breeding decisions. It has helped me drive the replacement index in my herd by increasing the reliability figures. 60% of all female progeny on the farm are either 4 or 5 star animals on the replacement index. Because I have been collecting data for a number of years, my ICBF data is significantly more reliable than the national average. My replacement index has an average reliability of 44% compared to the national average of 28%. This is because my weighings (birth and weaning) are “filling in the gaps” missed on most farms (where the index is primarily driven by calving stats, mart and factory weights alone). The reliability for my cows' milk figure is 61% reliable versus a national average of 38% (driven by weaning weights). Details of my farms replacement index are given in Table 2.

Table 2 – Key replacement index figures

	Replacement Index		Milk PTA		Calving Interval PTA	
	€	Rel %	kg	Rel %	Days	Rel %
My Herd	91	44	4.13	61	-1.23	34
National Average	74	28	4.8	38	-1	20



I have been farming for 20 years and I have an archive of information on my animals. For me it's about knowing my animals in a scientific way. I can measure their output by weighing and I can use this information to tweak the system and make more informed decisions. I realize that my data is also driving the Euro-Star Indexes of my herd so I try to record as much information as I can so that those indexes are as accurate as possible. I record all information accurately, otherwise "I am only fooling myself".

Table 3 outlines the performance of the cows that have been in my herd over the years when they are ranked based on their replacement index star rating.

Table 3 – Performance results of cows that have been in my herd

Star Rating	Avg. Rep Index (€)	Age at 1st Calving (Days)	Avg Calving Int. (Days)	Progeny ADG (kg/day)	Birth Weight
5 Star	122	765	361	1.18	44.5
4 Star	80	755	365	1.16	45.5
3 Star	67	749	364	1.12	44.8
2 Star	47	743	360	1.15	45.8
1 Star	15	754	363	1.13	46.1

Squeezing more benefits out of genomics

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Summary

- Genomics is simply the study of DNA.
- Observed animal performance is a function of its DNA and the management it was, and is, exposed to.
- Many uses exist for DNA including parentage verification/assignment, mating advice to minimise inbreeding, monitoring of major genes or unfavourable DNA mutations, as well as increased accuracy of genetic evaluations.
- The incorporation of DNA information into national genetic evaluations increases the accuracy of the proofs, thereby, reducing the extent of the fluctuations in proofs as more information on the individual or its relatives accumulates.
- The benefits of including DNA in genetic evaluations is well proven and accepted in dairying with 70% of dairy AI semen sold in Ireland last year being from DNA-tested bulls with no progeny.

The basics

Genomics is the study of DNA. DNA is the building blocks of genes and it is the genes that determine whether an animal has the potential, for example, to grow or be fertile– whether an animal achieves its genetic potential is dependent on the management and environment the animal was, and is, exposed to. DNA is present in all cells and remains the same throughout an animal's life; in other words the DNA of a calf taken at one day of age is the same as that animal's DNA several years later. Apart from identical twins, each animal has a different DNA profile. This is commonly referred to as the animal's *genotype*.

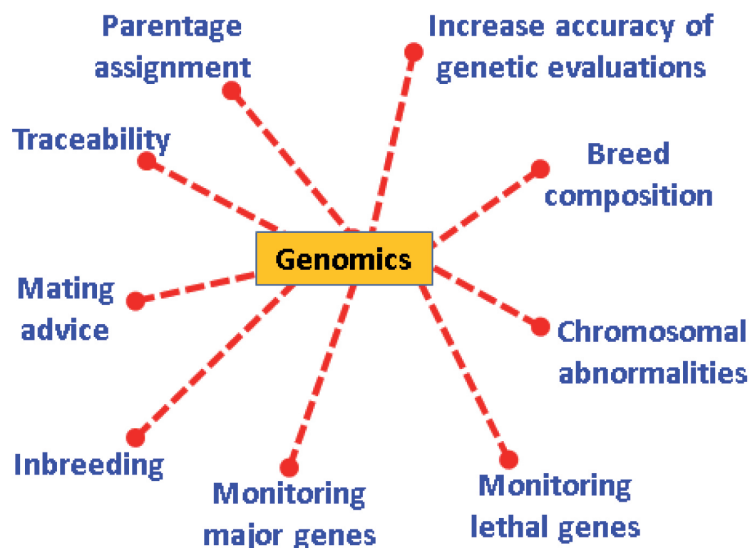


Figure 1. Potential immediate uses of genomics in cattle production.

The potential immediate uses of genomic information in cattle production is shown in Figure 1. Other more futuristic uses include personalised management, development of diagnostics, and vaccines amongst others.

Parentage assignment and traceability

The use of genomic information in cattle breeding is not new. Genomics has been used routinely in parentage testing, since the 1960's. Because each animal inherits half its DNA from its sire and the other half from its dam,

parentage verification can be accurately undertaken based on the DNA information of the individual and its parent(s). The extent of sire parentage errors in Irish commercial cattle is approximately 15%. Assuming bulls in Ireland have, on average, 70 progeny each, the 15% sire-error rate equates to a 12% loss in genetic gain for a trait like fertility and a 2% loss in gain for a trait like the carcass weight or conformation. Based on an optimal annual genetic gain of €8.42 in Irish beef cattle for the terminal index, the cost of parentage errors nationally for just the terminal index component of the beef herd is almost €270,000 annually. Previous DNA-based technology could only (in)-validate the proposed sire. In the absence of DNA information of the dam, where the proposed sire was not validated, the identification of the true sire could not easily be ascertained. Recent DNA technologies are not only more accurate, but also facilitate the identification of the true sire (and dam) of the calf if DNA information of the parent is in the ICBF database. Because DNA is unique to each individual (except identical twins), DNA can also be used to achieve full traceability – this is useful not only for traceability of meat samples, but also in the event of stolen stock. Coupled with the information available from the Cattle Movement and Monitoring System (CMMS) operated by the Department of Agriculture, having a complete and accurate national traceability system is advantageous when seeking new, higher-value beef markets.

Inbreeding, mating advice and breed composition

Inbreeding occurs when an animal carries two copies of the same chunk of DNA, both of which originated from a common ancestor. Inbreeding levels, or indeed relationships among individuals, are generally calculated internationally from just pedigree data. Even if the pedigree recorded is correct, the calculated inbreeding or relationships is not a very accurate estimate of the actual respective values; in fact, inbreeding calculated from pedigree has an accuracy of just 73%. True inbreeding can only be calculated from DNA information. Although difficult to believe, scenarios can exist where a mating between full sibs or between grandparent-grandoffspring can result in no inbreeding. This is illustrated in Figure 2. Each of the grand-parents (top of the figure) has two sets of identically coloured DNA. Each progeny receives one copy from its sire and one copy from its dam. These progeny in turn transmit, at random, one of their DNA copies to each of their two full-sibs (bottom of the figure). Clearly, based on the colour of the DNA, the two full sibs share no common DNA and are therefore unrelated. Similarly, each of the youngest animals is unrelated to one of their grandparents and so, therefore, could be mated without any repercussions for inbreeding. The chances of this scenario arising are extremely unlikely but can only be quantified when the DNA of the mates are known.

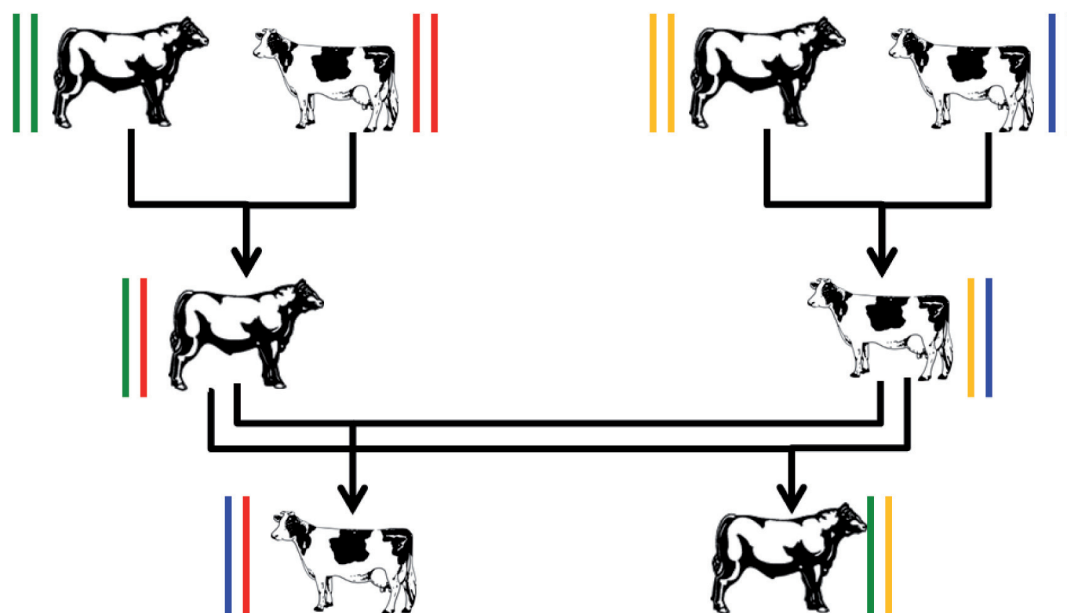


Figure 2. Possible DNA transmission scenario from grandparent to grandprogeny.

From pedigree alone, it is not possible to know the true breed composition accruing from a mating which involves at least one crossbred parent. Take for example a Charolais bull mated to an Angus-Friesian first-cross, the calf will be 50% Charolais but could range anywhere from 0% Angus to 50% Angus. The breed composition cannot be known without genotyping the calf.



Moreover, inbreeding generally has negative connotations and is often associated with inbreeding depression arising from a reduction in performance in inbred animals especially for traits associated with fitness. The double muscling in Belgian Blues is due to linebreeding, which is a form of deliberate inbreeding; the same may be true of the polled gene in Angus cattle. Therefore, inbreeding in certain regions of the DNA which do not affect performance are probably okay while inbreeding in regions of the DNA that affect performance can be good or bad. Examination of the DNA of an individual can be used to more accurately determine its inbreeding level and the impact on performance; inbreeding of the offspring resulting from a mating cannot be predicted with certainty from the mates although some estimates can be generated especially if the mates are genotyped. Therefore, DNA information can be used to slow down the rate of inbreeding but also target (or avoid) inbreeding at certain regions of the DNA.

Major and lethal genes, congenital defects and chromosomal abnormalities

Although not guaranteed, the manifestation of the effects of many mutations with lethal effects, and to a lesser extent congenital defects, can be due to inbreeding. The most common mutations in genes of known lethal effects are in dairy cattle and include CVM, BLAD, DUMPS, and Brachaspyina; the prevalence of carriers of these mutations in the Irish dairy herd is in Table 1. Many congenital defects have been discovered in beef cattle and include congenital contractural arachnodactyly also known as fawn calf, and Arthrogryposis Multiplex or Curly Calf Syndrome. Mutations in genes of known major effect include the myostatin (i.e., double muscling gene) and the mutations in the polled gene(s). Although it can be predicted with some certainty the genotype of an animal based on several progeny, having the genotype of the animal provides greater certainty and potentially at a younger age. For example if a bull has 5 polled calves then there is a 96.88% probability the bull is a double copy carrier for the polled variant. Knowledge of the genotype of an animal is important to minimise the mating of carriers of lethal mutations but also managing the animal differently based on either its genotype or the expected genotype of the foetus.

Table 1. Percentage of carrier Holstein-Friesian animals for known lethal recessive mutations

Percentage carriers	
Brachyspina	1.76
CVM	2.28
BLAD	0.53
DUMPS	0

One mutation in particular myostatin (i.e., nt821) increases the risk of a difficult calving. If the sire and dam are each carrying one copy of that mutation, then there is a 25% chance that the foetus will carry two copies which could translate into a difficult calving. If the animals has two copies of the mutation then there is a 50% chance the calf will also carry two copies (if the dam has one copy). Almost all Belgian Blue animals carry two copies the nt821 mutation associated with difficult calving, resulting in a calf who will almost certainly be a double copy carrier; this is why elective caesareans are the norm from such matings. The frequency of the different myostatin mutations within the Irish beef purebred population is in Table 2.

Table 2. Allele frequency for a range of mutations in the myostatin gene for different purebred beef animals

	nt821	FL94	Q204	Xnt748	nt324	nt267	nt414	nt748	nt419
Angus	2.0	99.7	50.0	20.8	100.0	0.0	79.2	20.8	0.0
Blue	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0	0.0
Charolais	0.0	83.6	85.2	32.3	95.3	0.0	67.7	32.3	0.0
Hereford	0.0	99.8	49.9	57.2	99.9	0.0	42.8	57.2	0.0
Limousin	2.3	5.79	7.5	5.3	100.0	0.09	5.3	5.3	50.4
Simmental	0.0	99.9	100.0	31.3	97.7	15.8	68.8	31.3	0.0

Everybody has 2 sets of chromosomes, one set inherited from each parent. Chromosomal abnormalities are relatively common and generally refer to changes in the number of chromosomes an individual has (i.e.,

numerical abnormality) or can also be due to large pieces of a chromosome duplicating, missing, or moving to another chromosome (i.e., structural abnormality). Down Syndrome in humans for example is when an individual has 3 copies of chromosome 21 rather than 2 copies. While each female is supposed to have 2 X chromosomes; Turner syndrome is a phenomenon which occurs once in every 2,500 in human females and is where the female only has one X chromosome. This is a non-inherited effect and the female is almost always sterile. Figure 3 illustrates the chromosomes of a 3-year Irish Turner syndrome Holstein heifer; she was inseminated several times but did not establish pregnancy. Examination of her reproductive tract at slaughter revealed tiny ovaries implying sterility. The genotype of this animal could have been used to alert the farmer at birth that she was not suitable for breeding.

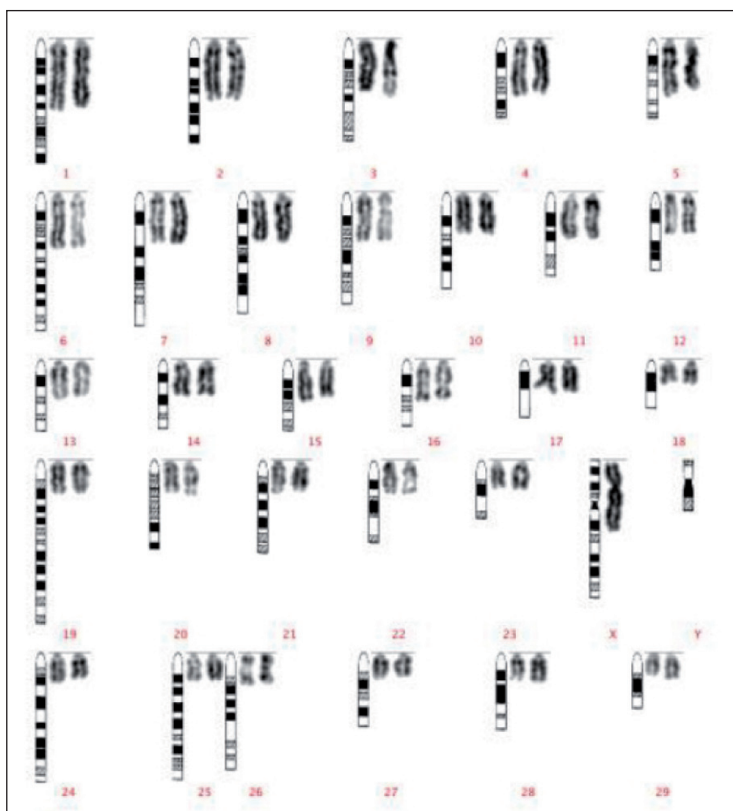


Figure 3. Chromosomes of an Irish Turner syndrome heifer with only one X chromosome detected from available DNA information

Genomic evaluations

The first step in a successful genomic selection program is to accurately quantify the impact each piece of DNA has on a range of different animal characteristics recorded such as growth rate, carcass traits, fertility, and other traits of economic importance. To achieve this, genotype and performance records on several hundreds of thousands of animals are required. These animals can be either cows themselves or their sires/progeny. The greater the number of animals with both genotypes and performance records available, the greater will be the subsequent accuracy of genomic predictions of young calves.

Based on earlier research in beef cattle in Ireland, it was obvious that a very large population of genotyped and phenotyped animals would be required to develop an accurate genomic evaluation that worked well across breeds. This led to a national initiative to genotype a large population of Irish beef cows; the sole aim of this initiative was to determine the optimal DNA profile (i.e., genotype) for a range of different traits in Irish beef cattle. The objective of the on-going beef genomics scheme is to use this developed knowledge to increase the accuracy of identifying genetically elite replacement females. The impact of using genomic information on the reliability of genomic evaluations is shown in Figure 4. A clear benefit of including genomic information exists especially for animals with low reliability based solely on pedigree information. Such animals are generally new-born calves or indeed cows; proven AI bulls benefit less from DNA information because, by definition, proven bulls are already proven and their DNA merit has already been accurately predicted from their progeny who received half their DNA from the AI bull.

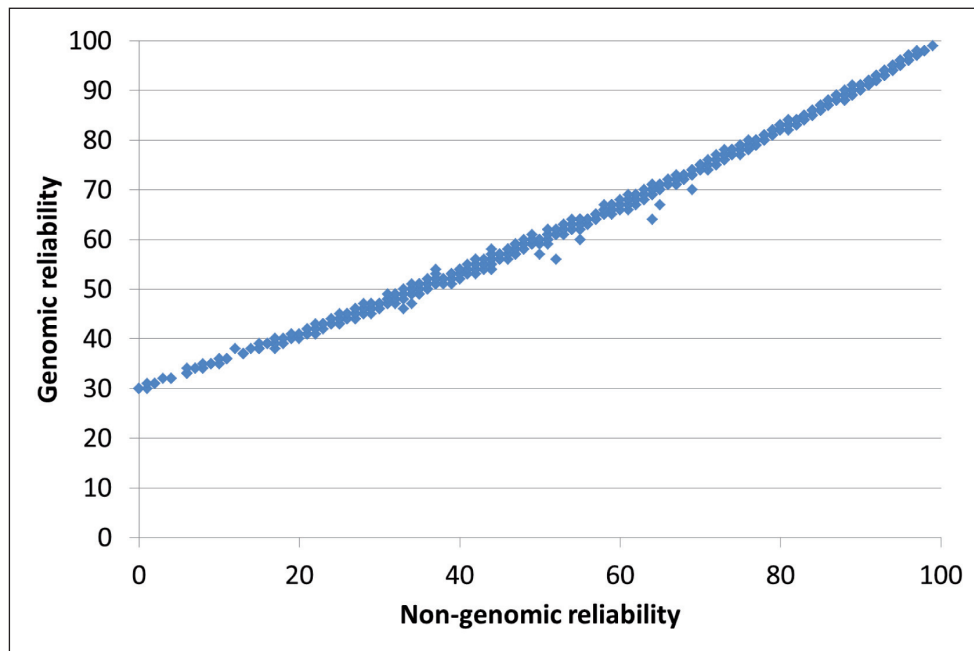


Figure 4. Increase in reliability in terminal index reliability from including DNA information in the genetic evaluation (blue dots) over and above not including genomic information.

Reliability, as the name suggests, is simply a measure of how confident the ICBF are on the genetic evaluation published for a bull. The reliability of a new-born calf is simply quarter the reliability of the sire plus quarter the reliability of the dam. Therefore the reliability of a calf from a young stock bull son of an AI bull (reliability ~30%) and heifer (reliability ~25) will be 14% (i.e., $\frac{1}{4} \times 30 + \frac{1}{4} \times 25$). When genotyped, the reliability of the calf will, on average, increase to approximately 36%. The impact of improved reliability of genetic evaluations for both the terminal and replacement on the range in which an animal's index can change as information accumulates is in Figure 5. For example, for the 14% reliability calf with an terminal index of €150, it's true terminal index could be anywhere from €81 to €219; when the reliability increase to 36% following genotyping, the possible range in terminal index varies less, between €90 and €209. Five percent of the time, the true index value of the animal could be outside this range. Therefore, genomics does not stop fluctuations in proofs over time, but it reduces the range in fluctuations. The overall impact of increased reliability is greater population average genetic gain. For example, increasing reliability from an average of 30% to 47% (Figure 5) will increase genetic gain per generation by >25%.

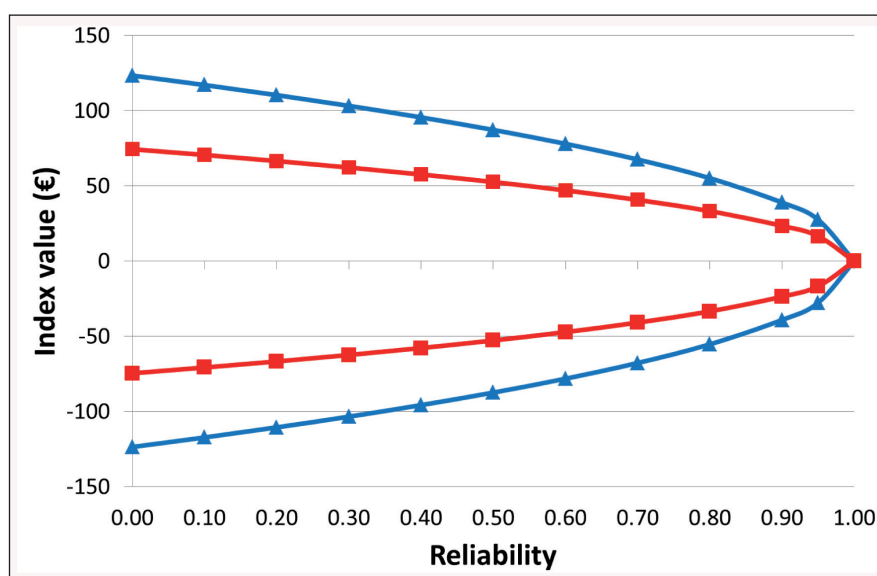


Figure 5. Interval within which the true terminal (red) and maternal (blue) index value of an animal can be relative to its estimated index value for a range of different reliability values; the true index value can lie outside these ranges 5% of the time.



Genomics and precision management

Personalised medicine or nutrition (commonly referred to as nutrigenomics) is topical at present in humans. The fundamentals behind such strategies are that the medicinal treatments, remedies or strategies as well as diets are tailored to the genotype of the individual. For example, certain mutations in two genes, BRCA1 and BRCA2, are known to increase the risk to various cancers. If an individual is carrying the unfavourable mutations, then the individual can undertake more frequent and detailed screening, can embark on prophylactic approaches (e.g., mastectomy), or can engage in chemoprevention approaches. Similarly individuals with a genotype mitigating a greater risk of cardiovascular disease can alter their diet and exercise regime to reduce the risk.

Such personalised management in cattle is not novel. For example, Charolais and Belgian Blue cattle are generally fed and managed differently to Angus or Hereford cattle. Nonetheless, considerable differences exist within breed and thus animals can be managed based on their genetic potential for growth and, for example, genetic predisposition for fat deposition. Similarly, animals differ in genetic predisposition to various diseases – the accuracy of identifying animals of different genetic risk to diseases can be augmented by supplementing the genetic evaluation with DNA information. Such information can subsequently be used to segregate animals based on risk and managed accordingly (e.g., vaccinate high risk animals and monitor closer for subclinical disease). Information on genetic risk can also be used when purchasing animals – for example, based solely on pedigree data, 31% calves born in the 10% greatest risk category for tuberculosis succumbed to the disease while only 5% of calves in the lowest 10% risk category for tuberculosis succumbed to the disease. A similar trend was observed for other diseases based on their respective genetic evaluations. Genomic information can be used to further increase the accuracy the segregation potential.

Conclusions

The new technology called genomic selection will increase the reliability of genetic evaluations of cattle; the extent to which the reliability improves will depend on the number of animals with genotype and performance information available. The increased reliability from genomics means greater confidence that the published values of a given animal will translate into progeny performance or in other words less fluctuations in proofs over time. This contributes to accelerated genetic gain. Although most commentary globally is on genomic evaluations, further potential benefits from genomics also exist. All benefits can be realised from just a single biological sample which could be blood, hair, ear biopsy, meat, or semen and is available to all farmers for €22; this price is 8% of the cost several years ago and is expected to become cheaper in the coming years. Put the word genomics in your vocabulary as it's here to stay and its impact on cattle management and breeding is only going to intensify.



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