British Cattle Conference

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75TH ANNIVERSARY

DIGEST 78

'Challenging Traditions'

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Annual Conference Papers 23rd - 25th January 2023

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British Cattle Conference

Organised by

The British Cattle Breeders Club

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Message from the Chair

'Challenging Traditions'

The call for debate, discussion and change was strong at this year's 75th British Cattle Breeding conference, with the theme of "Challenging Traditions" well and truly living up to its name.

Delegates, sponsors and speakers all got stuck in and questioned our farming practices, values and above all, mindset with some brilliant discussions being had.

Calling on experience from at home and abroad, we were able to create a space that allowed people to really think about what they wanted from their businesses, what the market was asking from us and what global trends dictated. And the result was amazing. We were inspired, excited, moved and challenged throughout the three conference days, learning from each other and paving the way for breeding and genetics to advance change in our industry for the better.

We also focussed heavily on the concept of sustainability, appreciating that the true meaning of the word is in danger of becoming lost. There are three pillars to sustainability. Social, economic, and environmental and we heard from our amazing speakers, how they knitted the three together in a way that benefited both their businesses and the industry. Whether that be undertaking cutting edge genetic research or using appropriate breeding and management tools, they all had a firm grasp on what a sustainable agriculture industry should be and did a fantastic job in inspiring us all to take a look at the way we do things and make the relevant changes needed.

But above all, we focussed on mindset. Mindset that enables us to grasp opportunities, scientific and genetic advancements, and profitable management practices. After all, as one of our international speakers, Arron Nerbas, said "The answers are right in front of us if we choose to see them".

As well as enjoying every one of our brilliant speakers, we also celebrated the 75th anniversary conference with a black-tie dinner and charity auction in aid of the Farming Community Network, raising £3,237. I'd like to thank everyone that donated items and to all those that put their hands in their pockets on the night.

Being Chair of the British Cattle Breeders club for the last year has brought nothing but joy and I am immensely proud of all that the club has achieved with the conference. We are a unique family of farmers, scientists and industry members, all dedicated to the advancement of genetics and breeding in Britain and above all, making the link between science and practice, so that the information can be used successfully on farm.

I would like to thank the club and committee for the opportunity to steer the 75th anniversary conference, it's an experience I will never forget, and I wish our new Chairman, Ben Harman, all the luck in the world. I can't wait to see what 2023/2024 brings for the club.

Amy Hughes

The British Cattle Breeders Club

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1965	Professor Alan Robertson OBE, FRS (retired 1987)
1988	Dr Tim Rowson OBE FRS (died 1989)
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1997	Mr John E. Moffitt CBE, DCL, FRASE (retired 2005)
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2011	Dr Maurice Bichard OBE (retired 2017)
2017	Professor Mike Coffey (retired 2023)
2023	Mr Duncan Sinclair FRAgS, FIAgM

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(Please note, the year of office would be completed at the conference of the following year)

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1962–1993	Colin R. Stains
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1999–2000	Janet Padfield
2000–2015	Lesley Lewin
2015 *onwards*	Heidi Bradbury

Epigenetics – the route to a simpler suckler system?

Arron Nerbas
Nerbas Bros. Angus, Manitoba, Canada

This article was written by Amy Hughes, Senior KE Manager at AHDB Beef & Lamb after she had spoken to Arron Nerbas to get an insight into Nerbas Bros. Angus.

Epigenetics is a word that we are starting to hear more frequently in the world of livestock breeding, but what does it mean and how do we apply it, practically, to our businesses?

Nerbas Bros. Aberdeen Angus is a multigenerational business that runs across 3 families, Arron, his brother Shane and their respective families and their parents, Cynthia and Gene. The business is based on a regenerative and holistic model, with low inputs and cattle that thrive in a forage-based system. Spread over 5000 acres, Nerbas Bros. run 550 pure Aberdeen Angus on a 100% perennial forage-based operation which focusses on improving swards through grazing management, bale grazing and seed bank infusions.

In the mid-2000s, the family made the decision to place focus on a cow type that fit with a lower input, holistic model and that was able to thrive on forage only. After looking, unsuccessfully, for local bull suppliers that fit the bill, Arron decided to go down the route of AI, which they have used extensively in the herd since. 'Our breeding goal is very singular. To make better cows that are the most efficient animal at harvesting our forage, with minimal intervention from us.' And minimal intervention they have, with the herd generally only being handled 4 times per year. The genetics that have been brought into the herd have focussed on a moderate frame, moderate mature weight (570 kgs), a defined forage type. The family have also paid close attention to moderate weaning weight, yearling weight and milk EPDs and a high feed efficiency value. 'There is nothing terminal about what we do. Every animal born has to be capable of replacing the animals before them. It is all about the cow.'

The herd is run as a commercial herd of 475 pure females and 75 pedigree, unrecorded, females. 'Extreme growth and carcase EPDs do not favour the system that we're running here. If we were to start focussing on those traits, the system would have to change' said Arron 'We keep our nucleus of 75 registered animals, to keep a track of lineage and to see what effect we can have by introducing different traits of influence.' The pedigree herd has always produced some of the bulls for in house usage, however, going forward all the bulls used within the herd will come from these 75 animals, as the family have taken the decision to become a fully closed herd, following the extensive use of AI over the past 20 years. Arron said, 'This is a gamble in some ways, but we feel that our genetics are now in the right place for our business.'

The main market for the business is the sale of breeding stock, with 70, mainly unregistered, bulls being sold per year. A large proportion of which are sold to repeat customers. The rest of the bull calves are castrated and sold on the open market. 'When we take our steers to auction, there is a difference in the way they look compared to other cattle that have been bred for growth and carcase traits. We don't receive any less for them though' says Arron. The top ⅔ of the herds heifers are selected as quality replacement females, with the businesses own replacements being kept from these and the rest sold privately to buyers that run a similar system. The rest are sold on the open market and go to other, grass-based systems. 'Everything is selected by eye, and we have a keen focus on type. We need a forage capable animal that has capacity,' said Arron. Extremes are also avoided, with the largest and smallest being further cut from the initial selection of heifers. The pedigree replacements go through the same process, but pedigrees and gene pools are also considered to keep the herd balanced for future matings.

The family work on 95% of the land being in a recovery state at any one time, with the cattle being moved every 2–3 days. 'On average, the whole farm will be grazed 1.5 times over the course of the year, but this varies. Some of our more productive land will get grazed 3 times' says Arron 'Our mindset is very much that we don't like to do anything that a cow could do herself. So, if any of the forage goes to seed, we'll just stock that area at a higher rate for a couple of days to allow the cattle to trample the seeds in and improve the lay for next year.' All cattle are outwintered and the business has never used any artificial fertiliser.

So how does a focus on Epigenetics

fit into such a simple, low input system? ‘Epigenetics, to me, means anything that effects phenotype but that isn’t related to the genome itself’ says Arron. ‘We have applied continual management pressure across our whole herd for years. By not focussing on individuals and having a herd first approach, only the type we want stay in the herd and produce progeny to replace them.’

In terms of maternal performance, the herd excels. With only a 55 day breeding period allowed, 60% calving in the first 3 weeks and assisted calvings at less than 2%. ‘Barren cows are pulled out when we handle the cattle for the calves first vaccination. We usually pull 5–10%, some of which will have calved and lost them.’ ‘Having a short breeding period like this, keeps the selection pressure for fertility on constantly, it also keeps the calf crop uniform and the system simpler.’

At weaning, the cows are kept as one group and put on bale grazing for roughly 4 months until the next calving. ‘We don’t split our cattle according to body condition score, if they can’t hold their condition correctly, then they don’t suit our system. Most cows would wean at BCS 3 with around half a score put on whilst on bale grazing before calving.’

So, what about data? Nerbas Bros. Aberdeen Angus take a ‘herd first’ approach to management. However, they do recognise certain traits in cow families that they like or that particularly fit the system. ‘These are the cow families that we make a point of trying to reintroduce sires from as we move forward.’ ‘We don’t weigh stock or work out what % of her body weight she’s weaned, I just don’t think in our system, it’s necessary. You can obviously see which ones have underperformed by eye, and as long as you cull those animals from the herd, you’ll make progress.’ The business also puts emphasis on heifers grazing with their mothers from birth to weaning, in what Arron calls ‘forage training.’ ‘When others view our herd, one of the main comments we always hear is that our cows are always grazing. Heads down all the time,’ said Arron.

The breeding goals of Nerbas Bros. Aberdeen Angus are extremely clear. By applying strict selection pressures that fit with the system and sticking with the overall goal for the business, Arron and his family have been able to produce a cow that works for them in a profitable way. ‘I believe focussing on epigenetics has improved our whole herd over time’ says Arron. ‘You could evaluate individual animals and chase their performance, but then you would end up with a herd full of cows with different input requirements, which just doesn’t work for us.’

‘It’s really just letting the system take over the selection process, taking the human element out. The result is a consistent and predictable herd.’

During development, the DNA that makes up a gene accumulates chemical markers that determine how much that gene is expressed. The different environmental pressures put on that gene, rearrange those markers, meaning that genes are expressed in different ways.

Epigenetics = How the environment influences the expression of genes.

Food sustainability – where does beef fit into feeding the world?

Professor Geoff Simm
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Food systems context

Our farming and food systems have responded remarkably well to feeding a rapidly growing population over the last century. As part of this response, the wider availability and affordability of animal-sourced foods (ASF) has contributed to food and nutritional security in many parts of the world. However, our farming and food systems face further challenges still. Continuing population growth is a major driver of these challenges – the population topped 8 billion recently and is set to approach 10.5 billion by the end of this century (UN, 2022). But it is not just about feeding more people, changing dietary preferences add to the challenge. Consumption of ASF has grown disproportionately over the last few decades (e.g. over a 5-fold increase in meat consumption in 60 years; Alexandratos and Bruinsma, 2012; Our World in Data, 2022) and consumption is expected to continue to rise, especially in lower and middle income countries. In some respects, the wider availability and affordability of ASF is a success story, but ASF can have both positive and negative health impacts. Even modest amounts of ASF can contribute to the wellbeing of children and other nutritionally vulnerable groups in some of world's poorest settings (Grace et al., 2018). However, high consumption of some ASF has been linked to a number of diseases. (More broadly, our food systems and diets need to change globally if we are to tackle the 'triple burden' of malnutrition: obesity, micronutrient deficiency and hunger, and their health consequences.) ASF are also usually more resource intensive than many other foods, which exacerbates the effect that our food systems have on natural habitats and biodiversity.

Climate change poses twin challenges for our food systems. On the one hand we must reduce the contribution food systems, especially ASF, make to greenhouse gas (GHG) emissions – around a third of all emissions come from food systems (e.g. Crippa et al., 2021). On the other hand, our systems must adapt to unavoidable climate change – with temperature rises, changes in rainfall, and more frequent extreme events challenging current food production systems in many regions. For livestock, the biggest impacts are on feed availability and quality, the growing risk of heat stress in many parts of the world, and new disease risks (CCAFS, 2022). Climate change is becoming an increasingly important driver of food insecurity globally. The number of people living in acute food insecurity had been falling in the early years of this century, but has begun to rise again as a result of protracted conflict in several parts of the world, climate-related natural disasters, the covid pandemic (FAO, 2021), and the recent steep rise in food prices. (Our work in the Jameel Observatory https://jameelobservatory.org/ is seeking to improve anticipatory action to climate induced food shocks among pastoralists in East Africa, whose livelihoods depend on cattle and other livestock, and who are one of the groups most vulnerable to climate change.)

Livestock production – especially the dramatic growth in production globally – contributes to many of these food system challenges. As a result, the debate on the future of livestock production is often extremely polarised. However, as well as being part of the problem, livestock systems need to be part of the solution too. So, where does beef fit into feeding the world? In the rest of this paper, I will briefly review beef production's 'balance sheet' or scorecard when it comes to sustainability, before outlining some of the targets for innovation – especially in breeding – that can help increase sustainability and thus support a long term positive contribution. The local and global challenges are interconnected, so I touch on both.

Beef's sustainability 'balance sheet'

In examining beef's balance sheet, it helps to consider three pillars of sustainability: economic, social and environmental, though they overlap (see longer discussion in Simm et al., 2021). The beef sector's major economic importance (around US$ 400 billion globally) is an important asset. However, the sector also has significant liabilities arising from its contribution to the challenges outlined above. As for the social dimension, beef is a valued dietary component for many, and an important source of dietary protein, energy and highly bioavailable micronutrients. Cattle also produce important co-products, including manure, and in many parts of the world transport and draught power, as well as being important cultural and capital assets. Livestock as a whole contribute to the livelihoods of around 1.7 billion poor people, the majority of whom are women (FAO, 2019). However, high consumption of red meat is believed to be associated with a higher incidence of some diseases (Dietary Guidelines Advisory Committee, 2020), and livestock farming and ASF are associated with some zoonotic diseases (diseases that can be transmitted to humans from other animals).

There are public concerns over animal welfare in some beef production systems. With respect to the environmental pillar of sustainability, some beef systems, including well-managed grazing systems, locally and globally, support biodiversity and carbon sequestration. De Oliveira Silva et al., 2017, showed that restoring degraded pastures in Brazil could reconcile competing goals of livestock production with reduction of deforestation and GHG emissions. Such restoration is now a key part of Brazil's international commitment to GHG reduction. Many beef systems make use of 'low opportunity cost' feed sources that cannot be consumed directly by humans (grassland, co-products from crop or other food production etc.). Beef breeds and the variation within them are important genetic resources, and part of agricultural biodiversity. However, the expansion of cattle production globally contributes to the loss of vital natural habitat, both directly and via land use for feed production. And lastly, ruminants in general and cattle in particular make a significant contribution to GHG emissions, especially via methane from the rumen.

Targets for improving sustainability

Optimal performance in sustainable systems

Despite the scale of the challenges, there are many opportunities to increase the sustainability of beef production. The overarching aim could be defined as to breed and manage for optimal performance in economically, socially and environmentally sustainable systems. While the specific challenges and priorities will vary from country to country, there will be common themes. Economic priorities usually include profitability, productivity and efficiency but, depending on the country and context, cattle may be valued mainly as financial and cultural assets. There is a particular need to improve productivity in regions or systems where this is low, yet environmental impact per unit of food produced is relatively high – so called sustainable intensification. Social priorities include the contribution of cattle farming to livelihoods; the affordability of the end products; animal welfare and the wider 'social licence' of systems, including the technologies used. Key environmental issues include GHG emissions; carbon sequestration potential; the use of land, water and other natural resources, and the circularity of systems; and impacts on nature and biodiversity, whether by sparing or sharing land for nature. Improvements in livestock breeding, nutrition, health and management can make major contributions to many of these priorities. For example, Capper (2011) compared the resource use of US beef production in 1977 and 2007. Beef produced in 2007 required 69.9% of the animals, 81.4% of the feed, 87.9% of the water and 67% of the land, while producing 81.9% of the manure, 82.3% of the methane, and 88% of the nitrous oxide, with a carbon footprint 16.3% lower than that of beef produced in 1977, as a result of such improvements. We need better metrics and tools to measure and manage system performance on this broad set of social, economic and environmental criteria (see e.g. https://www.trinityagtech.com/).

Low opportunity cost feed

'Meat: the Four Futures project' (https://tabledebates.org/meat) suggests four alternative future scenarios for meat, based on Garnett (2015): no meat, alternative meat, efficient meat and less meat. While improving resource use efficiency will usually be beneficial in futures involving meat production, it will be difficult for ruminants to compete with monogastric livestock on cost of production, resource use efficiency and GHG emissions, because of fundamental differences in their biology, including their reproductive rates. Ruminants fare better when considering a broader set of criteria, including their ability to use low opportunity cost feed sources and, in well-managed systems, their ability to support biodiversity. Van Zanten et al. (2018) showed that livestock's ability to use co-products and other low opportunity cost feeds means that arable land use is minimized when between 16 and 40% of the human diet comes from animal sourced protein not, as many assume, with no ASF. In my view it is important that future breeding programmes and production systems support rather than dilute this 'USP' of ruminants e.g. by evaluating the genetic merit of animals in relevant systems. New livestock feed sources – such as insects, algae, novel microbial proteins – could also help reduce competition for land capable of growing human food directly.

Reducing methane emissions

A key priority for ruminant systems must be to reduce methane emissions. A range of studies has investigated the ability of dietary changes, feed additives, vaccines and breeding approaches to do so. The use of feed additives for housed cattle and breeding approaches are probably most likely to have impact in the short term (see Simm, 2021; Simm et al., 2021; Defra et al., 2022). Breeding for improved productivity already delivers indirect benefits in terms of GHG emissions per unit of product. Very rough calculations based on the resource use changes reported by Capper (2011) in the US, typical contributions of breeding to these system level improvements (Simm et al., 2021), comparative rates of genetic gain in US and UK beef breeds (Amer et al., 2015), and the contribution of productivity gains to GHG emission intensity (GHG per unit product) in other species (Simm, 2021) suggest that cumulative annual gains of 0.3–0.4% are probably being achieved now. So, reductions of the order of 8–9% in GHG emission intensity could be achieved by 2050, the intended date for achieving 'Net Zero' carbon in the UK and other countries. This could be enhanced further – probably doubled – by including selection on breeding values for emissions measured directly or via proxy measurements. There appears to be genetic variation among cattle in the population of rumen microbes they host, and so the levels of methane produced. This offers a particularly promising approach for future breeding schemes which could further increase gains (see Martínez-Álvaro et al., 2022, and Roehe, this conference). Provided that there are no unintended consequences of selection for reduced emissions, with faster rates of genetic improvement, rapid uptake of new technologies to assist breeding for reduced methane, and faster and wider penetration of improved breeding stock into commercial beef herds, reductions of up to a third in GHG emissions intensity through breeding could be feasible by 2050 in the UK. Similar results should be achievable in countries with effective improvement programmes targeting emissions. We need better tools to allow both breeders and their customers to identify, and be credited in the supply chain for producing, better breeding stock.

Effective breeding programmes

With one or two notable exceptions, rates of genetic improvement in key traits in UK beef breeds lag behind those in the US and Australia (Amer et al., 2015). There are historical, and both herd and industry structural reasons for this, but there has never been a more urgent need to overcome these to achieve sector-wide improvement in resource use efficiency and environmental impact. This needs more effective breeding programmes, better and more data on key performance attributes, and wider recognition of the ability of genetic improvement to make meaningful changes in performance over time. The work of the Irish Cattle Breeding Federation (https://www.icbf.com/) over the last 20 years or so is an exemplar of what can be achieved in terms of co-ordinated, industry-wide, comprehensive recording, use of new data, new genetic technologies and modern genetic evaluation methods. And there are examples too of good practice in the UK in some breeds and supply chains.

Genomic selection has started to revolutionise livestock breeding since it was first applied over a decade ago. It involves selection of breeding stock based on the use of genome-wide genetic markers, usually alongside conventional performance records (Simm et al., 2021), to identify individuals and families carrying markers identified in previous studies as being associated with traits of interest. Genomic selection can allow earlier identification of the best breeding stock, and also allow selection for traits that are difficult or expensive to measure in practice – like feed intake, methane emissions, maternal performance and disease resistance – once markers have been identified that are associated with these traits. Genomic selection is superseding progeny testing in dairy cattle breeding schemes in many countries, as it allows earlier and more accurate estimation of genetic merit of bulls. Beef breed structures and breeding practices mean that the benefits are likely to be lower in beef cattle, but worth pursuing (Amer et al., 2015), as some breeds are now doing.

Advances in statistical, genetic and reproductive technologies will continue to offer new opportunities. For instance, gene editing can allow targeted beneficial changes in traits of interests – especially those controlled by one or a small number of genes, including polling and resistance to some diseases.

Clarity of roles and breeding goals

It has long been recognised that the low output of meat per breeding female per annum compared to other more prolific farmed species limits the efficiency of beef systems, and so too the GHG emission intensity of beef. Using animals produced as a co-product of the dairy sector is one way to improve resource use efficiency and GHG intensity, as the inputs to the breeding herd can be shared between milk and meat outputs (e.g. Poore and Nemecek (2018) reported a 60% lower GHG intensity for dairy beef).

Within the specialised beef sector, choice of appropriate breeds and crosses, to optimize cow size and other key lifetime performance attributes, is crucial to system efficiency. It is also important to have clarity over the roles and breeding goals of different beef breeds or lines within them for use in dairy and beef herds. As several key terminal sire and maternal traits are antagonistic, failure to distinguish roles when making breeding decisions leads to inefficiency. In Britain and Ireland a focus on terminal sire traits in dual purpose and maternal breeds or lines has led to deterioration in maternal traits in many. For instance, Byrne (2018) estimated that annual gains in terminal traits in Ireland worth €33 masked a deterioration in maternal traits of €25 per annum.

Conclusion

Our food and farming systems have responded remarkably well to the challenge of feeding a growing global population over recent decades. We are now facing even more complex and interconnected challenges that need systemic responses. Livestock systems contribute to these challenges but are also an important part of the solution. Reducing greenhouse gas emissions from beef systems is a key target, but not the only one! Beef production has a mixed balance sheet or scorecard when it comes to sustainability, with a range of economic, social and environmental assets and liabilities. It is becoming increasingly important to enhance the assets – and seek more equitable distribution of the benefits globally – and to tackle the liabilities of beef systems. Effective breeding programmes produce cost-effective, cumulative and, over time, very significant changes in performance, and so need to be a key part of this response. There is a need and an opportunity to improve the effectiveness of beef breeding programmes both in countries with a long history of genetic improvement, like the UK, and especially in those countries where it has not been widely used, productivity is low, and environmental impact per unit of food produced is relatively high. Beef will continue to make an important contribution to food and nutritional security for many, especially so if beef breeders and producers, and other key actors in the supply chain, embrace the changes needed. While science and technology can make major contributions in this quest, it seems unlikely that they alone can meet the challenge of equitably feeding 10.5 billion people well without further damaging the natural systems on which we all depend. This will need social, economic and political innovation and interventions too.

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Reducing bad calvings is good business (and how to do it)

Terence Pye
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When considering the performance, welfare and profitability of commercial suckler herds, it is not controversial to state that bad calvings are a bad thing, nor that a systematic approach to reducing bad calvings delivers significant benefits across all these fundamental aspects. Yet this issue, until recently*, has remained below the radar, with many suckler farmers appearing to accept as inevitable the frequent need for assistance at calving and the associated losses.

However, there is ample practical experience to challenge this traditional way of thinking. Suckler herds that have put an emphasis on tackling the causes of assistance at calving have brought about profound changes and demonstrated that they can go year after year with all their cows and replacement heifers calving entirely unassisted. They discover that their previous tolerance of bad calvings had deep pernicious consequences for their herd and themselves, the removal of which not only reduces deaths, illness of livestock etc, but that the range of unexpected benefits across the enterprise makes running a suckler herd an altogether more positive experience.

Consequences of assisted/bad calvings

Major financial and welfare losses arise from bad calvings, this list is not exhaustive. Perhaps part of the reason why farmers under-estimate these is because many take their toll long after the calving.

For the calf – death, injury, illness, stress, weakness, insufficient colostrum intake, unthrifty, needing special treatment, out of its group.

For the cow – death, injury, illness, stress, rejects calf, fails to rebreed or gets out of pattern, overly fat, culled early.

For the herd – more complicated management (pens of special needs), risk of disease (more replacements needed, or calves brought in to suckled on), disrupted block calving, more vet interventions.

For the farmer – (death, injury, stress), lack of sleep, inefficient working, impact on family life, depression, disappointment, loss of ££££ from all above, more ££££ for cameras, monitoring, special feeding.

Causes of assistance at calving

These fall into three broad categories:

1. Big calf stuck in small pelvic area of heifer/cow
2. Malfunction of the natural calving process, e.g., malpresentations, issues with twins
3. Farmer unjustified worries or impatience

The first category is essentially a mismatch between the birth weight of the calf and the size of pelvic opening in the heifer/cow. It is avoidable as these result directly from the breeding decisions made by the farmer. Following the action plan below will remove this as a cause of assisted calvings.

The second category is rare, and largely unavoidable. However, following the action plan will mean that less of them will be observed as the cow will calve more of them without assistance.

The third category of unnecessary farmer intervention is provoked by the amount of assistance needed in respect of the first two categories, the reduction of which (from following the action plan) will give the farmer more confidence to let well alone.

Action Plan to reduce assisted calvings in commercial suckler herds

The four pillars of the plan are:

1. Change suckler farmer attitude to assisting calvings
2. Ensure breeding females have adequate pelvic openings
3. Select sires to give appropriate calf birth weight
4. Account for the adverse impact that variants of myostatin gene have on breeding females

The best results are obtained when all of these are taken on board and become permanently part of the ongoing breeding policy.

Farmer mindset towards assisted calvings

This is the most important element of the action plan. The suckler farmer needs to be intolerant of assisted calvings and recognise that any assistance = loss, that it is not okay to go and give a ‘gentle tug’ just because you can see the calf’s hooves and to be disciplined to keep out of the calving pen until it is time to tag the calf. Breeding for calving ease must be given a high priority.

Pelvic area of breeding females

Heifers, selected as potential replacements, should have their pelvic area measured prior to service to assess that it is sufficiently large for the expected birth weight of calves by the sires used in the herd (see Figure 1).

> Pelvic area cannot be assessed from any external feature or trait and must be measured directly (internally) using a pelvimeter.

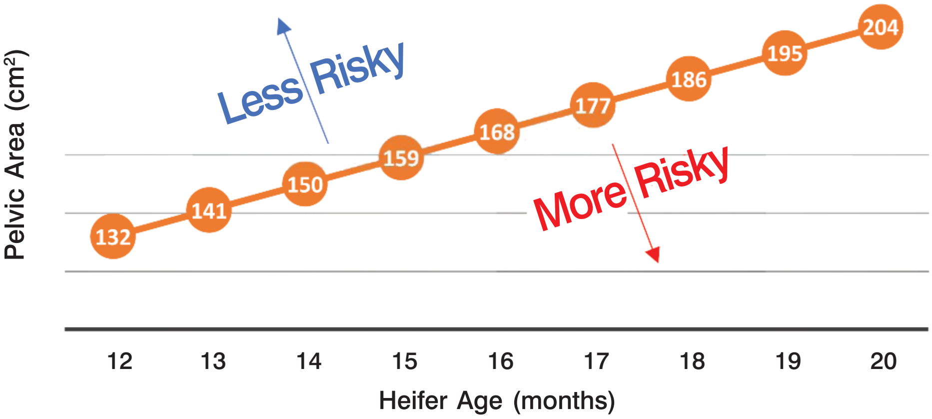
In the author's experience, Salers heifers make excellent replacements (the Salers is noted for it's very large pelvic area), nevertheless there is sufficient variability of pelvic area within all breeds to provide scope for rejecting the smaller pelvic area heifers from the group of intended replacements.

Bull pelvic area can be measured the same way as heifer pelvic area, and as pelvic area is a strongly heritable trait, for those breeding their own replacement heifers the use of a known large pelvic area bull will predictably increase the average pelvic area of his daughters. For reference, the Salers bulls in the Rigel herd are all pelvic area measured by a vet, and average 200cm^2 at 400 days.

Calf birth weight

In this aspect at least, there is plenty of advice for farmers elsewhere, but in a nutshell, select breeding bulls to use on your replacement heifers with predicted low calf birth weights. Look for high accuracy EBV (>90%) and aim to source bulls from performance recorded herds, ideally where all/most animals are recorded.

Figure 1: Guideline to the minimum pelvic area pre bulling.



This guideline has been developed from original research done in the USA in the 70's and 80's (Deutscher and others) and adapted to typical UK sucklers. It is being used successfully by a growing number of vet practices over recent years.

Pelvic area is a threshold trait, meaning the objective is to breed females with a sufficiently large pelvic area to permit unassisted calving, but there is no benefit to going beyond this to breed females with ever larger pelvic area.

The undesirable factor of heavy birth weight and the desirable trait of strong growth rate normally go together, so this is a question of balance. If your females have large pelvic areas, then you can use bulls with heavier birth weights to obtain stronger growth rates.

It is very helpful to weigh calves at birth to confirm that the sire EBV is a good predictor in your herd. For reference, with an average gestation of circa 283 days, the birth weights of Salers heifers are 32–36 kg, and Salers bulls calves weigh 36–40 kg.

Myostatin in suckler cows

The nine known variants (mutations) of the normal myostatin gene confer, to varying degree, important advantages within the terminal sire breeds (double muscling etc). Unfortunately, these variants also confer disadvantages on key maternal traits, again to varying degrees, including reduced calving ease, reduced fertility, reduced milk and reduced ability to convert forage.

For commercial suckler herds, to achieve the maximum advantage from using strongly muscled terminal sires with 1 or 2 copies of these variants, then the cows should be known to have 0 copies. Striking this balance protects the benefits of having a milky easy calving fertile dam who can maximise (off grass) the growth and conformation of her calf.

What outcomes can be achieved?

In short, a great reduction in the financial losses and welfare issues from the bad calvings listed above, which taken together transform the life and work of the suckler farmer. Looking beyond the benefits to the individual farmer, the significant gains in fertility, longevity, productivity and efficiency available if more suckler herds incorporated this approach would all contribute to reducing the 'carbon' per kg of beef produced by our industry.

For reference, the calving performance of the Rigel herd of pedigree Salers over the 21 years from 2002–2022 is as follows:

- Cows, 1581 calvings, 17 assisted (1.1%), with 4 of the 17 requiring the vet including 1 caesarean.
- Heifers, 288 calvings, 4 assisted (1.4%), no vet assistance required.

(*) the recent campaign by AHDB (Maternal Matters)

Feeding for fertility in the suckler herd

Dr Lorna MacPherson
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Background

Feeding the suckler cow is one of the largest costs in the beef industry. Existing research suggests that over one third of cows do not calve at the target BCS and are at least half a point away from the guidelines (on a 5-point scale) (Turner et al., 2021). This has implications for calving ease, calf survival and subsequent fertility. Therefore, there is a need to improve feeding management of suckler cows, especially at calving time to ensure that nutritional requirements are met for a successful, trouble-free calving and to protect future fertility.

Metabolic profile (MP) testing is a commonly used tool to assess nutrition in dairy herds but has had little uptake in suckler herds and tends to only be carried out pre-calving. Therefore, post-calving MP tests have not been conducted in Scotland prior to this project. It is a great way to 'ask the cows' what they think of their ration and can highlight areas of nutrition where corrections can be made to benefit calving performance, energy status and subsequent fertility. Farmers view nutrition as one of the most crucial factors influencing calving performance and fertility in suckler herds and funding was received from the Scottish Government's KTIF (Knowledge Transfer and Innovation Fund) scheme to support the investigation into MP tests to assess nutrition over the calving period and how that linked to herd fertility.

Project Aims

The aim of this project was to assess the nutritional status of suckler cows both pre-calving and post-calving and identify whether this information could be linked to subsequent fertility.

The specific objectives were:

- To investigate the nutritional status of suckler cows by using MP testing pre- and post-calving in spring 2020.
- To investigate the relationship between nutrition and subsequent fertility from dietary information and MP test results with pregnancy diagnosis data from the herds in late 2020.
- To determine whether a change in body condition score between the pre- and post-calving period affected cow fertility.
- To use the findings from these commercial suckler herds to produce practical recommendations on feeding management for future calvings to improve both technical and financial efficiency.

Methodology

Twelve suckler producers located in Angus and West Fife (Scotland) were recruited through their veterinary practices in late 2019 in preparation for the 2020 spring calving period. The participating farms were a mix of lowland, upland, and hill farms with a range of breeds from traditional to continental. These farmers were keen to know the nutritional status of their herd through MP testing as none of them had carried this out before.

Fifteen cows in each herd were selected to undergo blood testing approximately one month before calving and one month after calving. The following parameters were tested for, which provided information on protein, energy, health and mineral status:

- Energy status: non-esterified fatty acids, beta-hydroxybutyrate and glucose
- Protein and health status: urea, albumin, and globulin
- Mineral status: magnesium phosphorus, copper, selenium, and iodine

The aim was to select cows for sampling that would be calving at the start of the calving period and relatively close together, so they were as near to being sampled at one month pre-calving. Cows were selected based on when they calved in the last calving period and pregnancy diagnosis results, as some scanners were able to provide information on how far in-calf cows were when scanned. No heifers were included, or cows known to be carrying twins.

The selected 15 cows in each herd were body condition scored by the vet at the same time as blood sampling to determine the extent of body condition loss over the calving period.

Ration details pre- and post-calving were collected along with forage analysis and mineral supplementation information to assess whether the diet met protein, energy, and mineral requirements and this was reviewed in conjunction with the MP test results. Ration analysis was carried out through SAC Consulting's Feedbyte ration programme.

The effect of nutritional status at calving time on subsequent fertility was investigated through pregnancy diagnosis information in late 2020 to identify how many animals in the herd were pregnant and not in-calf. It was important to determine whether the 15 trial cows in each herd were pregnant and if not, was there a reason that could be identified from the MP tests over the calving period that could explain infertility? The following information was collected when the herds were ultrasound scanned for pregnancy diagnosis:

- Number of cows/heifers scanned
- Number of cows/heifers in calf
- Number of cows/heifers not in calf
- Number of sets of twins
- How many days in calf for each animal (if provided by the scanner)
- Confirmation on whether all 15 trial cows were back in calf

Calving dates in 2020 and historical fertility data were used to calculate key performance indicators to compare against industry benchmarks and provide farmers with recommendations for improvements. The following key performance indicators were benchmarked:

- Percentage of cows calving in the first 3, 6 and 9 weeks of the 2020 calving period.
- Percentage of cows in-calf and percentage of empty cows.
- Percentage of calves weaned per 100 cows put to the bull.

Results and Recommendations

Results

One third of cows were deficient in magnesium pre-calving (see Figure 1 which indicates the % of cows sampled that had blood parameters out with the target range). This is significant given the impact a lack of magnesium can have on slow calvings and then potentially the health status of the calf (how quickly it stands and suckles colostrum).

One quarter of cows were deficient in magnesium post-calving (see Figure 2). Again, this is significant to address, with low magnesium in cows going out to grass exacerbating the risk of grass staggers.

The other parameters that were often out with target levels both pre- and post-calving in the blood were urea (indicating a lack of rumen degradable protein) and non-esterified fatty acids (NEFA's), indicating a lack of energy in the diet and potential loss of condition. This could result in low colostrum quality and quantity if not corrected. Pre-calving, 50% of cows were struggling with their energy status and 62% of cows were short of dietary protein. Post-calving results were slightly better but there was still evidence of sub-optimal nutrition, with 20% of cows being in poor energy status and 37% of cows deficient in dietary protein.

From reviewing mineral supplementation, many herds were oversupplying minerals. It was extremely rare for any cows to be deficient in the minerals tested for other than magnesium.

While on paper the rations may have appeared to meet requirements, the MP tests gave the real picture of how the cows were coping and could therefore point to management factors that might be leading to suboptimal nutritional status (e.g., insufficient feed space, health/fluke issues and ration presentation).

Impact on fertility

While there were instances where the MP results looked poor, with cows

Figure 1: The percentage of pre-calving blood samples which had nutritional parameters out with the target range.

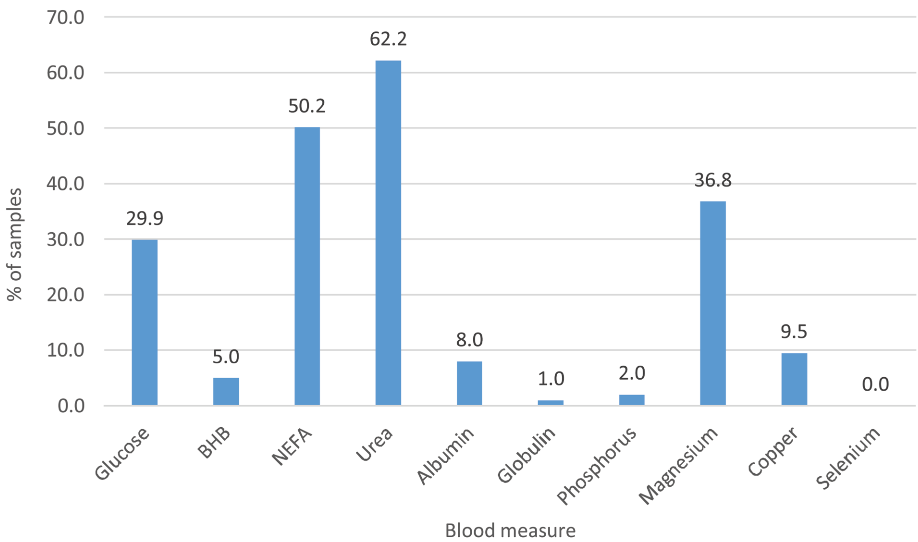


Figure 2: The percentage of post-calving blood samples which had nutritional parameters out with the target range.

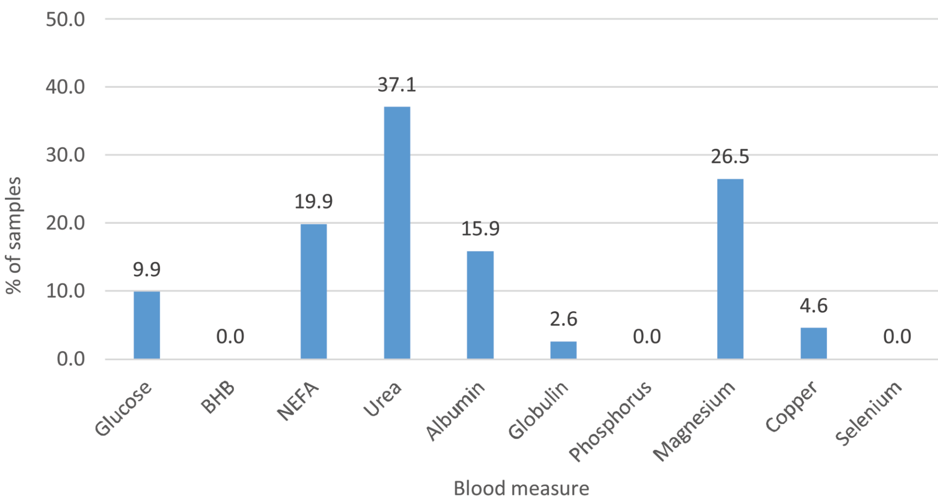


Table 1: Pregnancy diagnosis results of the 15 trial cows per farm

Farm	*Number of trial cows confirmed back in calf*	*Comments*
1	12	Three cows not in calf were all over 10 years of age and had normal blood results post-calving. Pre-calving, only two out of the three had poor energy status results.
2	13	For the two cows not in calf, one had a caesarean, the other had low albumin/high globulin both pre- and post-calving indicating likelihood of an inflammatory condition. Both cows lost 1.5 BCS units over the calving period.
3	15	11 cows had high NEFA post-calving and five lost 1 BCS unit over calving period.
4	15	12/15 cows had high NEFA's pre-calving but perfect set of energy results post-calving, despite fluke suspected by low albumin in five cows and four cows at BCS 1.5 post-calving.
5	13	Two cows culled so not put to bull (bad temperament and bad udder). Excellent blood results both pre- and post-calving.
6	15	Good energy status over calving period but blood urea low in all cows both pre- and post-calving (possible lack of rumen degradable protein?).
7	?	Does not scan.
8	15	More cows with high NEFA's pre-calving (9) versus post-calving (4).
9	9	Five sold and one out of remaining 10 not in calf. 14/15 cows with high NEFA's pre-calving but no issue post-calving.
10	13	One cow not in calf and one died pre-scanning. Low blood urea was much more of an issue both pre- and post-calving compared to energy results which were fairly good.
11	12	Two cows not in calf and one died pre-scanning. Energy status was much poorer pre-calving (12/15 cows with high NEFA's) versus post-calving (none with high NEFA's).
12	15	Low blood urea pre-calving was an issue and post-calving high NEFA's were seen in the majority of cows.

in poor energy status and had lost significant condition, farmers acted on the results to increase energy supply via concentrate feeding or providing access to good grass in preparation for bulling, 95% of trial cows got back in calf (see Table 1). However, it is unknown whether these cows took longer to start cycling after calving and hence got in calf later compared to the rest of their herd mates. This could only be determined based on calving dates in 2021 (which was beyond the timescale of the project). Therefore, the MP tests did not necessarily give a good indicator of future fertility. However, their benefit is that corrective action can be taken that will help improve the number of cows getting back in calf.

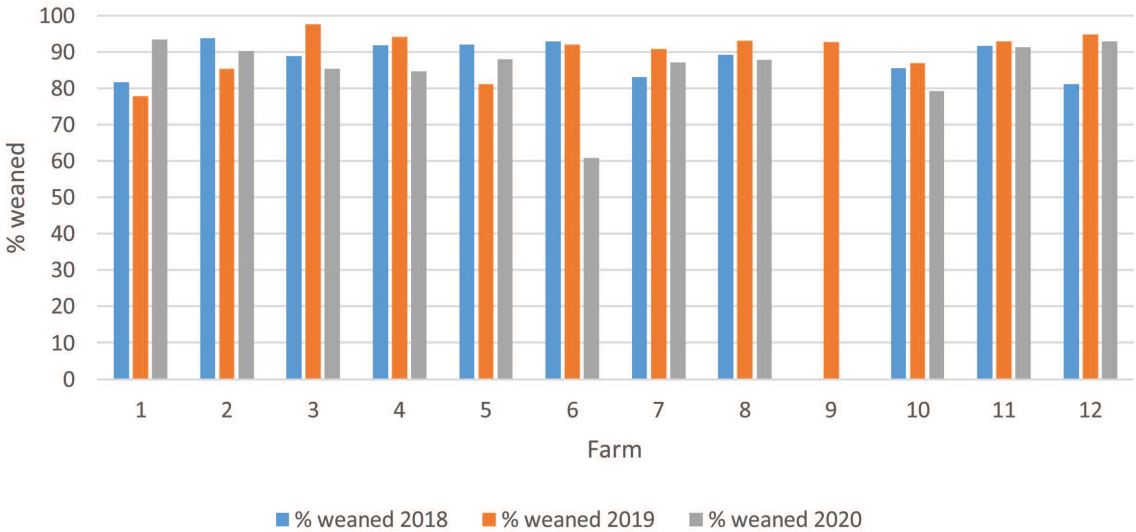
When analysing pregnancy diagnosis information and historic herd fertility data it became apparent that the industry targets for herd fertility are difficult to achieve consistently year on year, even by this group of highly capable farmers. Only three of the herds achieved the industry target of less than 5% barren (see Table 2 on page 16).

Very few farms ever reached the industry target of 94 calves weaned per 100 cows put to the bull (see Figure 3 on page 16). However, it is important farmers do not get dis-heartened by not achieving industry targets. Instead, what the farmers took from this project is that some of them need to record and analyse data more thoroughly to identify where improve-ments can be made and with expert advice, make management practice changes that could improve fertility and reduce calf losses. Keeping accurate records on where calf losses were occurring (i.e., from scanning to birth or from birth to weaning) was also highlighted to help with future breeding decisions.

Table 2: Whole herd pregnancy diagnosis results for the 12 farms

Farm	*% cows scanned in-calf*	*% cows scanned barren*	*Sets of twins*	*Calves/100 cows*
1	91.5	8.5	5	100
2	91.6	8.4	5	94.8
3	93.7	6.3	6	96.8
4	95.8	4.2	2	97.5
5	97.2	2.8	4	99.4
6	89.4	10.6	1	91.5
7	Does not scan	-	-	-
8	92.7	7.3	2	94.3
9	93.2	6.8	3	94.8
10	91.6	8.4	?	?
11	88.0	12.0	4	92.4
12	95.9	4.1	0	95.9
Average	**92.8**	**7.2**		**95.7**

Figure 3: Percentage of calves weaned/100 cows out to the bull.



Conclusions

It was difficult to link MP test results to subsequent fertility, with 95% of trial cows confirmed in-calf. Many cows with poor nutritional status over the calving period still got back in-calf, likely due to farmers taking corrective nutritional action, i.e., increasing concentrate feeding post-calving in cows with poor energy status may have helped prevent further condition loss, increasing their chance of getting pregnant.

MP testing has helped highlight what the key nutritional problems tend to be over the calving period and what farmers and their nutritionists need to focus on. The results also enabled farmers to make changes to nutrition to improve the nutritional status of the herd, which hopefully in turn helped to protect fertility and result in less barren cows.

This was a key outcome in that MP tests can be used successfully in the suckler herd to help manage nutrition and improve the outcome for calving and efficient herd fertility. It is also another way to assess health status as liver fluke was detected in two herds (on the back of low blood albumin levels), which might have taken longer to diagnose without the MP tests, resulting in poorer health status that could have adversely affected fertility.

On the back of MP testing, the majority of farmers taking part in the study found something they could alter to help improve future calving performance and herd fertility and expressed interest in continuing with MP testing for future calving periods.

Acknowledgements

This project was jointly managed along with SAC Consulting beef Specialist and Nutritionist, Karen Stewart. We gratefully acknowledge the financial support from the Scottish Government's Knowledge Transfer and Innovation Fund (KTIF) for this project. Thanks, are also due to Graeme Richardson of Thrums Veterinary Practice in Kirriemuir and Euan McKee of Cameron & Greig Veterinary Practice in Milnathort, for conducting blood sampling and condition scoring on participating farms. The University of Edinburgh was also a key partner, with veterinary expertise from Alastair Macrae at the Royal (Dick) School of Veterinary Studies where the blood samples were analysed through the Dairy Herd Health and Productivity Service. Expert advice was also provided by SRUC researchers Simon Turner and Kenny Rutherford.

Reference

Turner, S.P., Rutherford, K.M.D., Donbavand, J.E. and Jack, M.C. (2021). The impact of body condition in pregnant beef cows for calf welfare and lifetime productivity. Available at: https://pure.sruc.ac.uk/ws/portalfiles/portal/42459485/RB_Turner_et_al_2021_02.pdf (Accessed: 2 December 2022).

The supply chain benefits of an end to end beef operation

Richard Phelps
ABP UK Group Agriculture Director, Managing Director of Blade Farming

Synopsis

Richard will share learnings benefits and insights into an integrated beef supply chain model. He will also outline how working together, and by focussing on genetics, we can combat some of the challenges and avail of new opportunities as we face into the future.

ABP and Blade Farming

ABP UK are a food business that specialises in the supply and development of award-winning British and Irish beef and lamb products for retail, foodservice and wholesale. ABP UK have 16 operating sites, processing approximately 650,000 cattle and 1.2 million sheep annually, making up 20% and 7% of the national kill respectively. Blade Farming, part of ABP Food Group, was established in 2001 as the first truly integrated beef supply chain in the UK. The Blade Farming model, as shown in Figure 1, has been tried and tested for over two decades and offers a high health and welfare system to deliver consistent quality raw material to customer specifications.

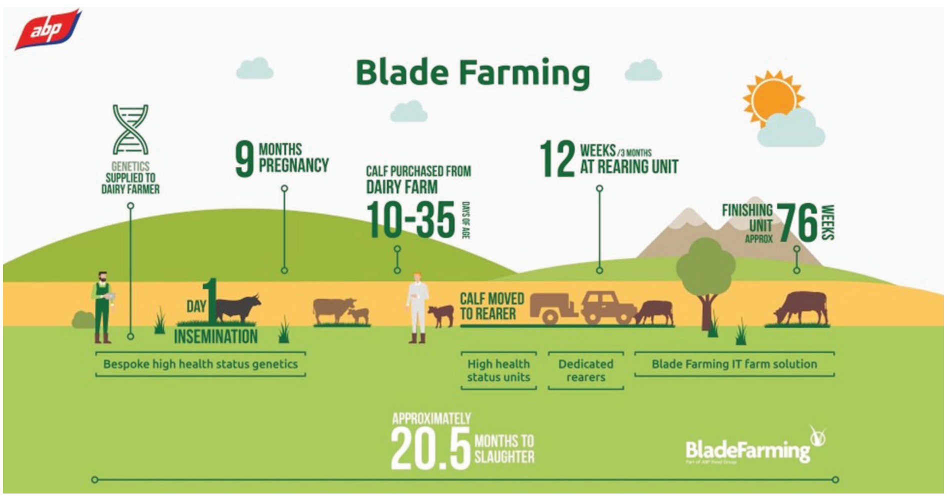
The supply chain benefits of an end to end beef operation

As shown in Table 1 below, there are benefits for all supply chain stakeholders of an end to end beef operation, including the farmer, processor, retailer and consumer.

Table 1: The supply chain benefits of an end to end beef operation.

Farmer • A forward pricing model to help manage risk • Ability to plan and forward purchase input products • Support and expertise from independent experts	**Retailer** • A bespoke fully integrated beef farming programme • Fully traceable from birth, rearing and finishing • A group of dedicated farmers working together • Ability to use the supply chain to promote to customers
Processor • Ability to forecast cattle more accurately • A consistent supply of cattle	**Consumer** • Consistent product offering the best possible eating experience • Lower carbon product *vs* standard product

Figure 1: Blade Farming.



Genetics

Blade Farming have breeding schemes in place using the best genetics available and encourage calf suppliers to take advantage of these genetics to produce calves that will command a premium in the marketplace. More recently, top Aberdeen Angus genetics have been secured, using DNA tested sires that are proven to have some of the best growth potential and eating quality in the world. As shown in Figure 2, dedicated sires selected for Blade

Figure 2: Blade Farming – genetic improvements.

Farming schemes are in the very top quartile of this index.

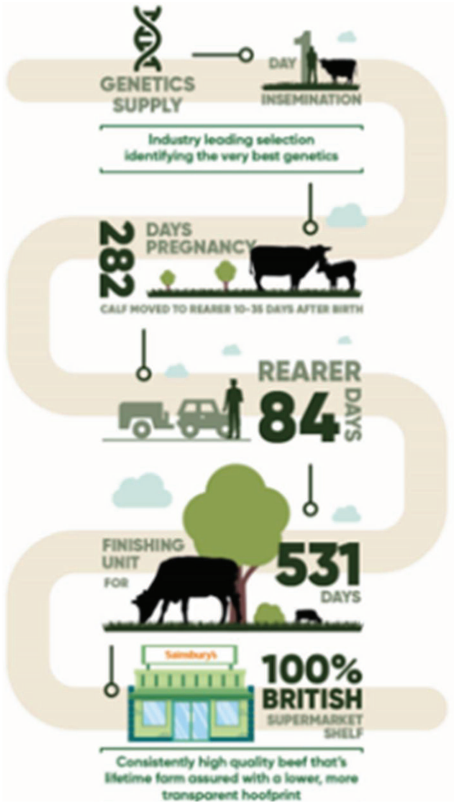
End to end beef operation example: Gamechanger

In 2012, Sainsbury's were the first British retailer to establish an integrated beef supply chain to explore the opportunities and challenges associated with integrated beef production. Years of learnings and insights from this, proved the value of integrated production and formed the foundations for what a new, bigger, integrated supply chain should look like. The Gamechanger integrated supply chain, as shown in Figure 3, started in August 2019, in partnership with ABP Food Group. Gamechanger is all about providing farmers with greater security and stability, embracing the very best in Aberdeen Angus genetics, and delivering amazing, consumer-friendly British beef with transparency, traceability and reduced environmental impacts.

Unique aspects of Gamechanger:

- Guaranteed forward pricing mechanism for dairy farmers, rearing and finishing farmers.
- Exclusive, industry leading genetics.
- Finishing farmers paid a management fee instead of a p/kg, known before animals arrive on farm and locked in for the lifetime of the animal.
- Finishing farmers have no capital outlay as cattle are financed through a 3rd party, unlocking working capital.
- Finishing farmers receive free farm management software.
- Opportunities for producer knowledge transfer and to engage in research and development.

Figure 3: Gamechanger.



Sustainability

ABP UK are working on a number of projects internally and with industry to support the environmental and economic sustainability of the industry. Launched in 2022, PRISM 2030 is a data driven initiative to improve the sustainability of red meat within the decade. Carbon Trust analysis shows that in common with other meat and dairy supply chains, 90% of the greenhouse gas footprint resides at farm level, 2% with processor, 4% with retailer and 4% with consumer. Therefore, ABP UK will be collaborating with a cross section of 350 beef and lamb supplier farmers, across all different sized farms, to explore how the UK beef and lamb sectors can make a step-change in sustainability. PRISM 2030, will be data driven, starting with carbon footprinting across all farms and then progressing to soil health, animal health, carbon, water and biodiversity with smaller interest groups, over a period of 2–3 years. ABP UK will then work with research partners at The Andersons Centre and Harper Adams University to compile, analyse and interpret the data.

Summary

Integrated supply chains have been operating in other sectors, such as pork and poultry, for some time. However, beef supply chains are more complex due to the lifetime of the animal and commitments required by all participants. Joining an integrated supply chain, such as Gamechanger, can offer significant benefits, as long as everyone involved works to a set of protocols. A truly integrated supply chain involves commitment from the customer to have integrity for the long term. Established models can share more information which may offer the benefits needed to make a qualified business decision.

Can bulk tank milk revolutionise TB testing?

Alastair Hayton BVMS DCHP MRCVS
Synergy Farm Health

Introduction to the Enferplex Bovine TB Antibody Test

The Enferplex test is a serological assay (identifies the presence of antibody) for bovine Tuberculosis (bTB).

The test detects the presence of antibodies within blood or milk to bTB by use of individual antigens. There are eleven different antigens used in the test and these are placed separately on individual spots within a testing well. If antibody to bTB is present in the blood sample being tested, then it will bind with the relevant antigen and the resultant reaction produces a luminescent reaction, the light from which can be measured and quantified (see Figure 1 and Table 1).

Thresholds are set for each individual antigen spot and if the level of Relative Light Units (RLU) as shown in Table 1 is above this threshold, a positive reaction is deemed to have occurred. The relative sensitivity and specificity of the test can be altered by changing the thresholds of the number of individual antigens, and the amount of antibody detected by those individual antigens, that are required to be positive for an animal to be determined as being positive to tuberculosis. The more individual antigens that are required to be positive, and the more antibody that is needed to be detected, for an animal to be deemed positive, then the more specific and the less sensitive the result will be. For the purposes of our application for WOAH validation of the test, the performance of the test has been evaluated at two cut-offs, a high sensitivity setting and a high specificity setting.

Table 1: Output showing quantitative output of the test

Spot ID	*RLU*
Ag1	60,119
Ag2	15,469
Ag3	52,118
Ag4	3,685
Ag5	29,121
Ag6	10,098
Ag7	54,434
Ag8	58,912
Ag9	22,551
Ag10	41,573
Ag11	65,232
Blank	300

The timing of sampling after a tuberculin test (TT) significantly affects the sensitivity of detection of antibody. Samples taken approximately 5–30 days post-TT will benefit from the antibody 'boosting' effect due to an anamnestic response to PPD antigens in animals infected with bTB. Samples taken outside this 'window' (non-boosted) will have lower levels of antibody and the test will be less sensitive, although still more sensitive than the skin test (SICCT).

Performance of the test

The performance of the test, at these high sensitivity and high specificity settings, against defined populations of TB negative and positive animals in the United Kingdom, Ireland and worldwide has been elucidated. This work was performed as part of the requirements for test validation by the WOAH. If the samples are indicated as boosted within the Tables on the following pages, this meant the sera

Figure 1: Images from three individual testing wells showing individual antigen spots that have bound antibody and are luminescent. This light is measured to produce a quantitative result as in Table 1.

Table 2: Diagnostic specificity of the Enferplex Bovine TB antibody test using individual serum samples and bulk tank milk

bTB-free animals	*Number of animals*	*Statistical Variable**	*High Sensitivity setting*	*High Specificity setting*
Serum Non-boosted	4258	RSp	98.4%	99.7%
		CI	98.0–99.0	99.5–99.8
Serum boosted	339	RSp	98.8%	99.1%
		CI	97.0–99.5	97.4–99.8
Bulk tank milk	1792	RSp	99.8%	99.9%
		CI	99.4–99.9	99.6–99.9

Table 3: Diagnostic sensitivity of the Enferplex Bovine TB antibody test using individual serum

bTB infection status POSITIVE by:	*Number of animals*	*Statistical Variable**	*High Sensitivity setting*	*High Specificity setting*
M. bovis culture	214	DSn	93.9%	93.9%
Boosted		CI	89.9–96.4	89.9–96.4
Visible Lesions	1179	RSn	96.1%	93.3%
Boosted		CI	94.8–97.1	93.3–95.9
SICCT test	1949	RSn	94.3%	91.9%
Boosted		CI	93.2–95.2	90.6–93.0
IFNg test	1341	RSn	90.0%	85.6%
Boosted		CI	88.3–91.5	83.6–87.4

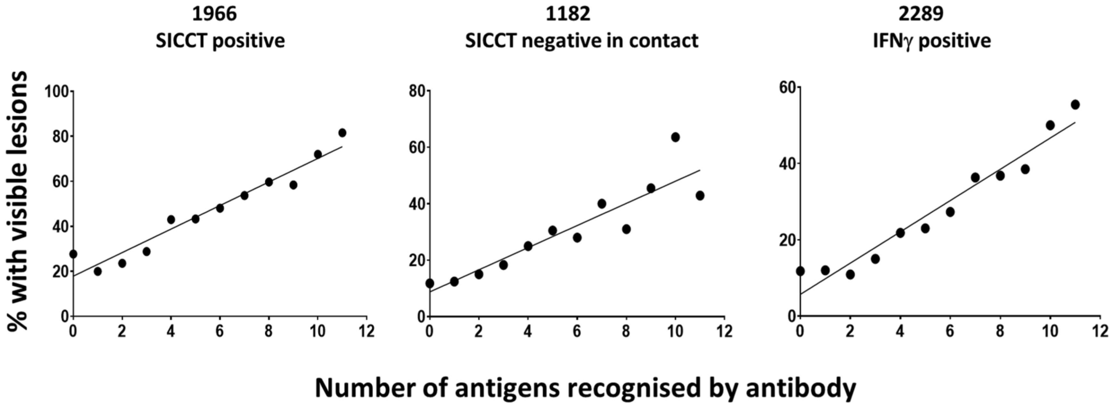
Table 4: Diagnostic sensitivity of the Enferplex Bovine TB antibody test using bulk tank milk

Test method under evaluation	*Number of animals*	*Statistical variable*	*High Sensitivity*	*High Specificity*
Relative sensitivity	247	RSn	77.7%	71.7%
(Bulk tank milks contained R alone or R + IR)		CI	72.1–82.5	65.4–76.9

that was analysed was collected within the 5–30 day window post tuberculin and thereby would be expected to have had an improved sensitivity, though it should be stated, that as it is anticipated this is when samples for the test would be taken in the field, the sensitivities displayed are appropriate to the expected performance of the test.

Relationship between Number of Antigens recognised and the Presence of VL in animals seropositive by Enferplex Bovine TB

As with Johne's disease, it is well accepted that in TB, as disease progresses, the production of antibody increases, and the strength of the cell mediated immune response wanes. We have analysed the correlation between antibodies, specifically the number of bTB antigens recognised by antibody-positive sera and the presence of VL at post-mortem examination. In total, 1933 SICCT test-positive UK and Irish animals were tested using the Enferplex Bovine TB antibody test at the high sensitivity setting.



The results were analysed with animals being classified as to how many antigens they recognised, e.g., 2 or more, 3 or more, etc., and this was correlated with the percentage with VL and as a percentage of the total VL animals in the population. The results showed that 91% of all Visible Lesions detected were in animals that had 5 or more antigens recognised by the Enferplex Bovine TB antibody test and that there was a good correlation between the number of antigens recognised by antibody and the presence of visible lesions in SICCT positive, IFNg positive or in-contact SICCT negative animals.

This diagram above shows that the Enferplex Bovine TB antibody test, as with Johne's Disease, serological tests can aid in the identification of epidemiologically important bTB positive animals as those with lesions tend to be those which are excreting bacteria and are therefore infectious (Casal et al, 2014).

Use of bulk tank milk

The test is already validated by the World Organisation for Animal Health (WOAH) for use on individual blood samples, and it is now being evaluated as a bulk tank test. The validation studies are complete but are waiting to be approved by the relevant WOAH committees this summer.

Along with its potential ability to detect whether a herd is infected or not, the test potentially may also provide information about the dynamics of the disease within the herd (i.e. is the disease status improving or deteriorating) via reviewing the changes in the combined value of how many of the eleven antigens have tested positive and in the total amount of antibody detected.

What are the potential gains of a bulk tank milk test?

This is the first time a bulk tank milk test for bovine tuberculosis has been developed. Herd surveillance for bTB in dairy herds using bulk tank milk could revolutionise bTB surveillance and control because:

- Samples are easy to obtain, robust, reliable, and the test is inexpensive to perform.
- If it proves effective, it could reduce skin testing requirements for farms whether this be in the high-risk, edge or low risk areas of England or Wales or in Officially TB free Scotland.
- By allowing continuous monitoring of herds, it allows more rapid detection of disease introduction, making eradication easier.
- By allowing an insight into the infection dynamics of a herd, it could allow for more bespoke and suitable control measures to be taken.

As the exact extent of the value of bulk tank milk testing is not known at this stage, there is a clear requirement to perform a thorough field trial to assess the test. The difficulty in doing this is that there is a very limited time to perform such a study without risk to individual farms and the wider industry, as if the bulk tank milk test is officially validated by WOAH this summer, the UK Government would have to place restrictions on any herd testing positive. Prior to this though, Defra and the Devolved Authorities have stated that they will not act on any positive results and are under no obligation to do so.

Fortunately, with the combined help and goodwill of the Government and Devolved Administrations and many participants within the dairy industry, we have managed to set up this study in a very short period of time with over 5,000 dairy farms across Great Britain participating.

The details of the study are set out below.

The Study

We will be testing the bulk tank milk from approximately 5,000 dairy farms from across England, Scotland, and Wales with the Enferplex bTB Antibody test. Enrolled farms will have their bulk tank milk tested every 2 to 3 months, with a smaller subset of milk recorded herds tested monthly. The study will start in early February 2023 and end in September 2023 (or whenever the test is formally validated if WOAH approve the test).

Testing will be performed at the National Milk Laboratories in Glasgow using the payment testing samples so no new samples would need to be gathered from participating farms. The test results would be sent by NML to Scotland's Rural College (SRUC) for analysis.

The SRUC statistical analyses will be anonymised before sending to Surefarm Ltd, Enfer Scientific Ltd and MV Diagnostics Ltd who would be responsible for collating and reporting the results to government, the farming community, and scientific journals.

The Government and Devolved Administrations have authorised this study to be performed.

Under law, Defra and the Devolved Authorities require the results of positive tests to be reported to them as a suspicion of notifiable disease. However, they have confirmed that there will be no repercussions for individual farms participating in the proposed study. Specifically, they will take no statutory actions if a bulk tank milk sample shows a positive Enferplex milk test result. The official TB status of any participating herds (whether free, suspended or withdrawn), and their normal TB statutory testing schedule will be unaffected by the study.

Specifically, the study will be focusing on:

- The test's ability to detect disease in herds currently under restriction. While the sensitivity of the test has already been elucidated for the OIE submission, this sensitivity was based on a single time point and the repeatability of the test may allow for an enhanced sensitivity for detection of bTB at the herd level. (The sensitivity of the test, where a reactor contributing to the bulk tank was disclosed at TT2 and the sample was taken between TT1 and TT2 is 77.7%)
- How many herds currently designated OTF would be determined positive by the test.
- Understanding the value of monitoring the level of bulk tank milk seropositivity as an indicator of whether a herd is moving either towards disease freedom where the levels are falling, or, vice versa, where the levels are rising, that the current actions are failing to control disease where the herd is already under restriction, or where the herd is currently OTF, predicting that a herd will lose its OTF status.
- Understanding whether there is relationship between seropositivity and risk of bovine tuberculosis (bTB) breakdown.

Summary

We are very grateful to all who have helped in aiding this study to go ahead. We very much hope and expect that the results will demonstrate a clear benefit of bulk tank milk testing to the industry in fighting this devastating disease and we look forward to reporting the outcomes in the future.

References

Casal et al. (2014). Strategic use of serology for the diagnosis of bovine tuberculosis after intradermal skin testing. *Vet Microbiol.* 170: 342–351.

Taking advantage of forgotten traits to improve efficiency of farm automated technologies

Ben Nottage
Dairy XL Account Manager, Lely

Milking cows is a complex and time-consuming process that requires significant effort, attention to detail, and plenty of consistency. As technology advances, more and more farmers are turning to robotic milking systems to streamline the milking process and improve efficiency. However, not all robotic milking systems are created equal with some systems being more efficient than others.

One factor that can impact efficiency is the genetic traits of the cows being milked, but how important are Robotic traits in reality?

In the UK currently, 10% of all cows are milked robotically! Lely alone will have an installation base of just over 3,000 robots by the end of 2023, and our growth model based on orderbook and historic numbers, predicts our installation number to have doubled by the end of 2028.

The demand for automation within the dairy sector is clearly growing at a rapid rate, and the thing to bear in mind is that a lot of the traits to keep an eye on for future robots, are also of benefit in your current conventional milking system.

Traits influencing efficiency

While many farmers are focused on breeding cows for traits like milk production, health improvements and disease resistance, there are other genetic traits that can have a significant impact on robotic milking efficiency. These traits are often overlooked or forgotten, but they can make a big difference in the performance of robotic milking systems.

Whilst the first two that probably always spring to mind are teat length and teat placement, there are several others that play their part, such as milking speed, udder depth, stature, mastitis resistance, lameness and temperament.

Currently, of all of those, the only two traits directly included in the make-up of PLI in a positive way are mastitis and lameness. Our suggestion is to carry on with your usual breeding criteria, but when you have a shortlist of sires that fit, then perhaps use some of the robot traits to differentiate between them.

Teat Length

The physical length of the teat wants to be ideally over 3 cm in length, but isn't the whole story, as you can have much longer teats that have no width, meaning cluster slip can be just as bad. The robot fairs better with shorter teats than a lot of conventional milking systems as there is less weight involved, due to having no claw to support.

The heritability of teat length is 29% (0.29), and so is worth putting some positive emphasis on where possible.

Teat placement

Teat placement is an important factor to consider when breeding cows for robotic milking systems. Cows with teats that are evenly spaced and hang straight down are easier for robots to milk. This is because the robot can more easily identify the teat and attach the milking cups without the need for human intervention.

The trait rear teat placement is nearly always the initial consideration, but the outcome is also hugely influenced by udder support and the angle of the teat. Other factors to look at are how the rear and fore teats line up, eg, if you have very wide rear teat placement and very close fore teat placement then it can become difficult for the robot to differentiate.

Again, the lack of claw and therefore pipe length restrictions, means that the robot can often handle uneven udders a little easier with cleaner milk out, due to the fact that the teat cups are always hanging vertically.

Rear teat placement and side teat placement both have a heritability of 29% (0.29).

Udder depth

The traditional view has always been to breed heifers with as shallow udders as possible. Shallow udders are not an issue for robots, but extremely shallow udders in combination with other traits at extreme levels (such as body depth and stature) can make attachment more difficult.

Other traits that play their part to influence overall udder depth are fore udder attachment and udder support.

Udder depth is a very heritable trait for the type traits at 35% (0.35) and so if you breed for extremes, you will see the results very rapidly in genetic terms.

Milk Speed

For many years the thought process has been that quick milking cows are very often the high cell count members of the herd. Very little data exists to prove or disprove the theory in conventionally milked herds, as very often the way milk speed is recorded leaves a lot of inaccuracy. The scale of 1–9 identifies the fastest and slowest milkers, but 2–8 often just get recorded as average, because we only notice the cows that come off early or are the last in the line to finish. The main reason for the link to high cells was that the cow had open teat ends and would leak milk in the bed and collecting areas.

In robotic systems we do not see a link between milk speed and cell counts, due to the cow's ability to go and milk when she wishes, meaning less is leaked in the bed, and there is no collecting area to wait in when in a free access system.

Milk speed is measured in kg's per minute on a robot system, with average being around 2.6, but several herds are achieving nearly 4.0 when the management and breeding in combination together have been focused on.

The conversation often goes along the lines of, lets make sure we don't use any slow milkers, the issue being that we are not putting enough positive emphasis on faster milking genetics. Milk speed is a huge driver of efficiency in robot milked systems.

Milk speed has a very high heritability in comparison to other management traits at 21% (0.21), whereas something like fertility index which is focused on regularly would be a much lower heritability in comparison at 4% (0.04).

Other influential traits

Stature

Extreme stature in combination with extreme shallow udder depth can mean that robots could have difficulty seeing where the udder actually is. There is no suggestion that poor udder support sires should be used, just perhaps steer away from the extremes in combination.

Mastitis resistance

It doesn't matter whether milking on a conventional system or robotic system, cases of mastitis cause a great deal of financial loss and wasted labour hours dealing with the cases.

Lameness

If genomic testing, then emphasis should be put on the lameness trait, as cows with any disease in the foot will ultimately visit the robot less because its simply too painful for them to want to go. These same cows go unnoticed in conventional systems as the whole group is taken to the collecting area for every milking.

Temperament

Temperament is another important genetic trait to consider when breeding cows for robotic milking systems. As a breed, the Holstein has become quieter and quieter over the years. Combine that with the fact that robot milked cows become so easy to handle anyway, and those outliers really do stand out. Don't think of temperament as an issue for the robot to milk the cow, as it is a robust machine that can handle it. The area that often people don't think about, is when you are in the pens working with the cows, that's where those flighty temperament cows really show up, and can risk upsetting the whole group.

The take home messages

Use the data…

Every minute of every day there will be live data streaming back from your robots, giving you a vital insight into your herd and its performance, on an individual and whole group basis. We certainly don't recommend death by data, but if you don't measure something, then how are you going to manage it?

Make use of all the health traits if you are genomic testing or using genomic bulls, lameness and mastitis will have an even greater impact on your business than they did before.

No drastic measures…

Do not throw the baby out with the bath water! Your genetic decisions have got you to a good place so far, and so keep with your existing balanced approach, but incorporate these traits where possible. Breeding has always been a steady process, but one that reaps great rewards in the long term, breeding for robot efficiency will be no different. Keep looking at the profit drivers, then if you need to decide between two very similar sires, see which have the better robot traits.

Remember – less than 1% of cows in new robot start ups have to be changed out of the herd. You haven't been breeding for robot traits for the last 30 years, and so there is no need to have a huge panic about them now. However, a little direction and focus on them going forward will make a huge difference to output in the years to follow. All of those small increments every generation will add up in the long run.

Collaboration to build social sustainability for the next generation

Catherine Pickford and Nathan Crocker
Dairy Farmers, Somerset

Background

I went back to the tenanted family farm in 1995 which was 250 acres, milking 80 Holstein Friesian cows and growing 120 acres of cereals. My mother had taken over the management of the farm in the 1970's after my father had had a serious head injury – juggling a full-time job outside of the farm as well as bringing up two children.

After leaving school, I had led a fairly nomadic work life completely unrelated to farming, however in the 1990's my father's health started to deteriorate further, and the decision was made that I would go back and run the farm.

In 1999 I was given a 20 year FBT. I was fortunate in one way in that my mother gave me carte blanche in how to take the farm forward. I didn't enjoy growing cereals, being beholden not only to the weather but also to the whims of contractors, so I worked hard at increasing the cows yield with a simple silage/maize diet, but found the profits were still hard to come by.

Our consultant Gerard Finnan (FCG) took a group of us over to Ireland in 2001 to see several spring block calving farms and a light bulb moment flashed when I saw how having a simple grass-based herd could not only improve my work/lifestyle balance but increase profit-ability by concentrating on keeping costs under control. Also, at this time I joined 'Gillingham Grazers' discussion group which was just being established.

We blocked up our AYR calving non-extreme Holstein Friesians to calve in the autumn of 2002, calved nothing in 2003 when we served everything to NZ jerseys and started block spring calving in 2004, only having crossbred calves from then on.

We gradually decreased the cereals as we increased the herd to 300 using our own replacements from our more fertile cows. Back then there were no crossbred heifers to buy, but this meant that we kept the good genetics we had within the herd – and more importantly increased profitability.

Nathan came to work for us part-time whilst he was at college at Kingston Maurward then full-time after leaving college in 2010.

In 2015 Nathan was keen to further his knowledge of spring calving systems so went to New Zealand for the calving period. The decision was made in spring that year to go once a day milking – partly because cow numbers were increasing, and the yard space and parlour was inadequate, and partly because I would be doing most of the work with occasional temporary staff during the time that he was away.

Once a day milking was very successful and probably caused more anguish for the management than the cows which after the second day didn't look to come out of the paddock in the afternoon.

My FBT ended in September 2019 and despite my numerous efforts to engage with the landlord with plans to invest in a new parlour and bring an antiquated farm into the 21st century, at my own cost, they were always turned down. So, the decision was made to try and find a new farm.

New Farm

In September 2018 I took on a 10 year FBT at Alford Fields, Lovington, a 500 acre farm about 12 miles from the old farm. The cows moved whilst they were dry in December 2018 and January 2019 and the young stock stayed at the old farm until the summer of 2019.

We transferred our milk contract with Barbers Cheesemakers – we were moving closer to the factory, so they were more than happy especially as we produce high solids milk that is ideal for cheese making.

The new farm had been quite run down and neglected though it did mean that it was a blank canvas for us. Monies were borrowed from the bank to put in a new 40/80 swing over parlour, associated equipment for 400 cows and for the general infrastructure of water troughs, fencing paddocks and tracks.

Works for this started in November 2018 and were almost ready by the time that we started calving in February 2019!

This was then an opportunity for Nathan to invest in cows and help him build up his capital within the business, which was something that we had been discussing for some time. We bought 50 in calf heifers from one source of which Nathan bought 20 – this enabled us to be milking 400 in the spring of 2019. We reverted back to twice a day milking purely because it aided cash flow whilst re-paying the debt.

Team

The team now comprises of myself, Nathan, 1 full-time, 2 part-time and an apprentice.

We involve all the team by having weekly breakfast meetings, where grass allocation, cow performance and KPI's that the team can influence are discussed. Everyone is encouraged to attend discussion group meetings, so that they benefit from getting off farm and seeing other farms.

All have a training course of their choice every year paid for by the business.

Full time employees work a five day week (40–45hrs) and everyone has every other weekend off.

All are paid a salary so that they can budget and not lose out during the dry period when hours per week are less.

Both of us are learning to deal with more staff. We enjoy having people that are keen to learn and progress. Experience we find is not essential as we can train people if they have an open mind and have a 'can-do' manner. We also try to have an apprentice, which sometimes can be challenging but seeing them gain confidence and progress is very rewarding.

Farm Technical Data

- Cows are dried off 20th December and planned start of calving is 25th February
- Calving 411 in 2023
- 180 followers
- Cows weighed annually in July
- Young stock weighed at birth then regularly through to calving to ensure on target to calve in at 450 kgs
- Aiming for a 500 kg mature cow producing 500 kg milk solids from 500 kg concentrate
- Current average (2021) 513 kg cow produced 475 kg milk solids from 600 kg concentrate
- Dry cows/Heifers out wintered on stubble turnips or loose housed on Hay/Silage Bales
- Young stock out wintered on deferred grass and silage bales
- Milk Recording and Johnes tested quarterly
- 2022 was the first year of using Sexed Semen. The herd was ranked for milk solids produced as a percentage of their body weight. The range varied from producing 141% to 50%
- The top 20% were served to sexed semen
- The middle 60% were served to conventional dairy
- The bottom 20% including all Johnes cows were served to easy calving Hereford/Angus/BB

Breeding is kept simple; if it looks like a Friesian, it's served to either a Jersey or Crossbred and if it looks like a Jersey served to a Friesian – Just to maintain a 500 kg cow.

All mating decisions are made prior to the breeding season and coloured coded onto a chart next to the AI flask.

2020 – 12% empty in 12 weeks
2021 – 12% empty in 10 weeks
2022 – 10% empty in 9 weeks (52% conception for SS, 60% conventional)
Target – 10% or under in 9 weeks

Succession

Firstly, I looked up the opposite of succession and found the words:

- Disagreement
- Decline
- Dispute
- Repudiation

Without any forethought to succession this is all too common, and definitely not what I wanted after working hard to build up a resilient business.

I then looked up the definition of succession and found that a successor is a person that takes on a job or position after someone else – this sounded infinitely more attractive and a way to encourage the next generation into farming. I followed this train of thought further and discovered the difference between inheritance and succession.

'*Inheritance is the process of an heir inheriting from ancestors*' BUT that '*succession governs how the inheritance takes place*'

This is something that should take place well before the event in order that the business can move forward with confidence financially and not be put at risk whilst issues arise regarding differences of opinions.

Initial succession plan

I pay Nathan a monthly cow hire charge for each of his cows in the herd.

I look after Nathan's cows as my own, i.e. Feed/Vet/AI costs and I have the value of the milk from them.

If they are sold either as cull cows or in calf out of the 9 week block, Nathan gets the value of them.

When they calve, I get the value of the calf.

If it's a dairy calf Nathan has the option to buy it back.

This is a rearing fee from weaning to calving (22 mths) which is paid monthly by Nathan to aid his cashflow.

Initial Plan

Table 1 on page 28 shows that working on a 15% replacement rate year on year and buying only the heifer calves from Nathan's own cows he would not reach his target of owning 100 cows by 2028.

We have recently reviewed and updated the initial plan after having a meeting with Phil Cooper (FCG) in order to find a path that suited us both.

New Plan

Table 2 still working on a 15% replacement rate Nathan will have to purchase a larger number of heifers per year to be in the position that he wants to be by the end of the tenancy. He is now looking at various ways to finance this (see Table 2 on page 28).

Future Business Structure

Plan A – would be for Nathan to take on tenancy at Alford Fields, we have already put the seed of thought to the Landlord – If this happens, Nathan would become a director of the

Table 1

Year	*Opening herd*	*Heifers*	*Culls*	*Closing herd*
2019	20	0	0	20
2023	20	8	4	24
2024	24	8	5	27
2025	27	9	6	30
2026	30	10	6	34
2027	34	11	7	38
2028	38	12	8	42

Table 2

Year	*Opening herd*	*Heifers*	*Culls*	*Closing herd*
2023	20	8	4	24
2024	24	8	5	27
2025	27	30	9	48
2026	48	30	12	67
2027	67	30	15	82
2028	82	30	17	95

company with me leaving money within the business for a return for my retirement.

Plan B – Would be to sell up at the end of the tenancy. I then retire and Nathan has options either to take on his own tenancy elsewhere, go share/contract farming or find another investor to go in partnership with.

Plan C – Would be to move farms again and keep a similar structure to Plan A.

With all these plans the key is to keep an open mind and continue networking with as many people as possible to be ready, not if, but when a gate opens.

Catherine's objectives

Short term – To get the new farm up and running as quickly and as profitably as possible. I needed to concentrate more on the business enterprise and needed someone reliable and knowledgeable to take on the day to day management of the herd and it seemed to me that the best way of ensuring this and also for Nathan to achieve his goals was for him to have a financial interest within the business.

Medium term – is for me to step back and for Nathan to take on more responsibility, not only with the day-to-day management but also involve him in the meetings regarding the financial management of the business.

Long term – is to have the option to retire at the end of 2028 and to tick a few things off the bucket list.

Nathan's objectives

Short Term – to grow cow numbers by buying heifer calves from own cows. He has taken the 'Focussed Farmers' and 'Entrepreneurs in Dairy' courses.

Medium Term – to own 100 cows and be in a position to take on my own FBT.

Long Term – 2nd Unit whether that be share/contract farming or another FBT.

Catherine's Lessons Learned:

- Always use a facilitator when discussing future plans – A business plan is needed to include the ambitions and goals of both parties.
- Be willing to delegate, but not too quickly – so not to overwhelm the successor.
- Be aware that mistakes will be made along the learning process.

Nathan's Lessons Learned:

- Only buy in animals when absolutely necessary – no matter how good the genetics they never last as long as home bred animals.
- Start buying calves sooner to get to aid cash flow and to get to goal sooner.
- Be open-minded and embrace change – Goals and plans develop along the way.

Take Home Messages

1. Start the process early and communicate openly.
2. Use a facilitator to ensure that both parties have the chance to share their goals and objectives – these should be written down and form part of the business plan – so that no misunderstandings creep in at any stage. They can be and should be updated along the way.
3. Surround yourself with the right people – nothing can beat belonging to a good discussion group and having excellent mentors to help and question your choices and decisions.
4. And last of all be confident that your successor is capable of managing business – you may well be relying on them to generate an income for your lifestyle in the future.

Climate smart efficient cattle though rumen microbiome-driven breeding

Professor Rainer Roehe
Leading Animal Genetics and Microbiome at Scotland's Rural College (SRUC)

The livestock industry in particular beef and dairy production is under a substantial pressure to achieve net zero greenhouse gas (GHG) emissions. The main GHG responsible for this is methane emissions from rumen fermentation of feed. Methane emissions from agriculture is a highly potent greenhouse gas (GHG) estimated to be 27.2 times higher than that of CO_2 (IPCC, 2021). Based on a recently released UN report, methane emissions are responsible for about 30% of the global anthropogenic emissions since pre-industrial times. Of these methane emissions, 32% are estimated to be from global agriculture mainly from cattle (United Nations Environment Programme and Climate and Clean Air Coalition, 2021). In the UK, 60% of the agricultural GHG emissions expressed as CO_2 equivalent are reported to be due to methane emissions (Brown et al., 2021). These emissions are estimated to be more than 80% from ruminal fermentation of feed especially from cattle. Therefore, reduction in methane emissions from cattle is one main aim to achieve net zero emissions from cattle production.

I think it is a combination of strategies necessary to achieve this net zero aim such as dietary intervention (e.g. seaweed, 3-NOP), change in husbandry and management systems (e.g. optimisation of days to slaughter) and breeding. Breeding for reduced methane emissions per kg beef (methane intensity) can be achieved by selection on performance traits such as feed efficiency, growth rate, longevity, animal health, fertility, mature cow size, gestation length and age at first calving. This strategy is known as indirect selection on traits linked to methane mitigation per kg product, mainly on those presently selected for in most breeding programmes. An increase in selection pressure on these indirect traits genetically correlated to methane emissions in the breeding goal or the creation of a specific index for climate smart efficient cattle using these traits could be used to focus selection more on reduction in methane emissions per kg product. A study in dairy by de Haas et al. (2021) predicted that selection over 32 years based on present traits in the Dutch breeding goal is expected to result in 24% reduction in GHG emissions per kg product. Although a recognisable contribution, the time to achieve the reduction in GHG emissions per kg product is very long so that direct selection for methane mitigation is required to achieve the UK net zero emission's goal by 2050.

Direct selection

Direct selection based on measured or predicted methane emissions is only effective if there are firstly large differences between beef cattle in methane emissions per kg dry matter intake under consideration that the animals have eaten the same diet, are housed, and raised under the same management conditions and are from the same breed. Secondly, these differences in methane emissions between beef cattle need to be linked to the animal genome and thus inherited from the parents to their progeny. Thirdly, the cost associated with measuring or alternatively predicting methane emissions of individual cattle have to be at a magnitude so that this breeding strategy is cost-effective.

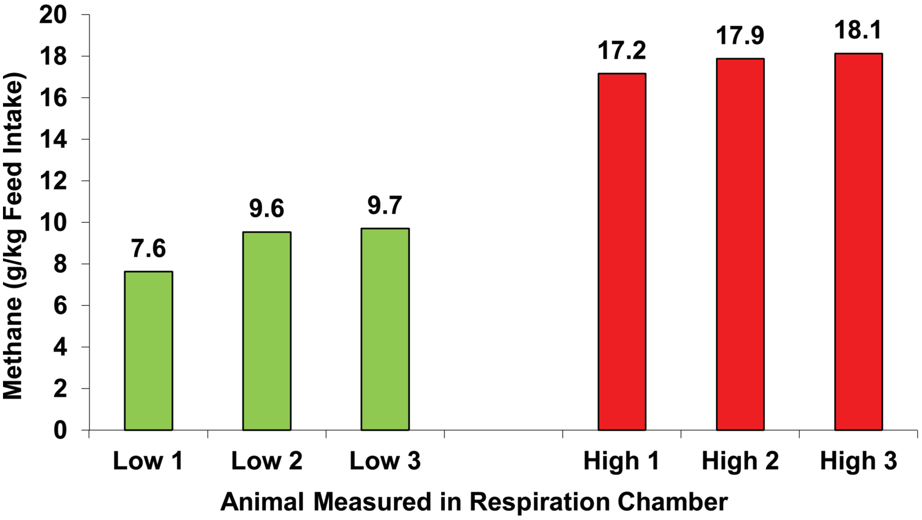
Difference of animals in methane emissions

At SRUC, we have measured methane emissions of individual beef cattle in respiration chambers and observed large differences in methane emissions between them. Figure 1 on page 30 illustrates that the low methane emitting cattle showing approximately half of the methane emissions per kg dry matter intake than those of high emitters. This is an excellent basis for selection for reduction in methane emissions if these differences are inherited, i.e., transmitted by genes from the sire to its progeny.

Animal genetic impact on methane emissions

In an earlier study, we found that there are significant differences between sire progeny groups in methane emissions (Roehe et al., 2016) indicating that there are AI bulls inheriting low methane emissions. Recently, we estimated based on the SRUC population, which consist of Aberdeen Angus and Limousin rotational crosses, Charolais crosses and Luing, a moderate heritability of 0.33 for methane emissions (Martínez-Álvaro et al., 2022). The magnitude of this heritability is similar to that, e.g., of growth rate and feed efficiency, indicating that selection for methane emissions will be as successful as those traits, most likely even higher due to the large difference in

Figure 1: High differences in low and high methane emitting cattle (same trial, breed, diet, feed Intake, rearing and husbandry; Roehe et al., 2016)



methane emissions between animals within breed. Our estimated heritability for methane emissions is in the range of those reviewed by Brito et al. (2018), where 60 heritablity estimates for methane emissions of different studies in beef and dairy cattle as well as sheep were analysed. Recently, Hossein-Zadeh (2022) reported a review of heritability estimates of different methane emissions traits in different dairy cattle populations which are further confirming that the cattle genome influences the production of methane of methanogenic archaea in the rumen.

Measuring of methane emissions

SRUC has an excellent GreenCow facility, where we measure methane emissions individually in respiration chambers. These chambers are the gold-standard for measuring methane emissions from ruminants. They have to be large for cattle to not alter their behaviour and thus methane emissions (see picture below). Methane emissions measured in respiration chambers are mostly used in experiments to identify the genetic impact of this trait, to test the effect of diets to mitigate these emissions or for validation of proxy measure-ments to predict methane emissions. We used the respiration chambers mainly to identify the accuracy of rumen microbiome information to estimate methane emissions from beef cattle. This was necessary because it continues large scale genetic evaluation of cattle, the use of respiration chambers to measure methane emissions is too costly and therefore we investigated to use the rumen microbiome as cost-effective proxy trait for estimating methane emissions of each individual cattle.

Rumen microbiome composition to determine methane emissions

The rumen contains a very dense microbial ecosystem comprising of different bacteria, protozoa, fungi and methanogenic archaea. This microbial ecosystem within the rumen is essential in cattle due to its ability to convert by cattle enzymes indigestible fibrous plant material (e.g. grass) into absorbable nutrients used to produce high quality beef. As a result of unnecessary excess hydrogen produced during microbial conversion of feed, the rumen microbial archaea population produces the by-product methane, which is expelled through mouth and nose into the atmosphere. Several studies identified microbiome biomarkers as accurate proxies for estimation of methane emissions, most likely due to the fact that the synthesis of methane from ruminants is a direct consequence of the microbial metabolism in the rumen (Roehe et al., 2016; Auffret et al., 2018; Martínez-Álvaro et al., 2020). Rumen microbiome also plays a key role in cattle growth performance (Myer et al., 2017; Lima et al., 2019), since approximately 70% of their energy requirements are from volatile fatty acids produced by microbial fermentation in the rumen (Bergman, 1990). In addition, microbial protein produced in the rumen is the major protein source of cattle (Strom and Øskov, 1984); and many microbiome-derived metabolites act as regulatory signals in the microbiome-gut-brain

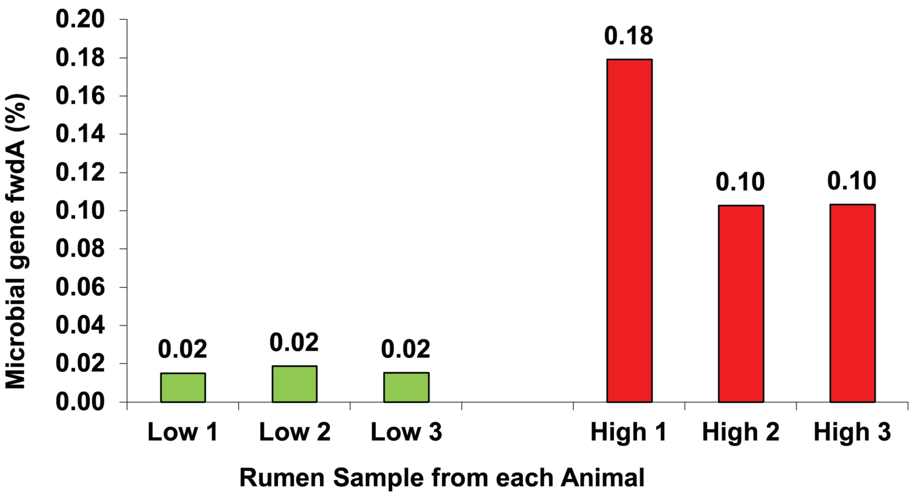
axis (Carabotti et al., 2015) which may influence feed intake and feeding behaviour (Sommer and Bäckhed, 2013). Therefore, microbial biomarkers have also been used to predict feed efficiency, feed intake and growth (Lima et al., 2019). The influence of host genetics on the rumen microbiome, firstly suggested by Weimer et al. (2010) after a ruminal microbiome exchange, is now widely recognised not only in cattle (Roehe et al., 2016; Li et al., 2019; Zhang et al., 2020) but also in many other species (Bergamaschi et al., 2020; Chen et al., 2018; Tabrett and Horton, 2020). This opens up the opportunity to use the composition of the rumen microbiome for prediction of complex traits such as methane emissions and feed efficiency, not only for their phenotypic prediction but also for estimation of their breeding values.

Selection of the most informative microbiome information

For the same animals as shown in Figure 1, we observed that the abundances of the microbial genes (here for example the microbial gene fwdA that catalyse the first step of methane metabolism) are even more sensitive to identify low and high emitting cattle as shown in Figure 2. This was the first indication that the abundances of microbial genes are highly informative for prediction of methane emissions.

However, there are further other factors to be considered that the abundances of the microbial genes can be used as efficient breeding criterion. The microbial gene must be present in the vast majority of animals in the population (i.e., be part of the core microbiome), exhibit wide phenotypic variation among animals, be heritable, and be genetically correlated with traits of interest, here methane emissions or feed efficiency. Our research as collaboration of SRUC, Genus plc and the University of Edinburgh revealed that approximately 30% of the composition of the functional core microbiome is influenced by host genetics, with heritabilities ranging from 0.15 to 0.66 (Martínez-Álvaro et al., 2022). Similar ranges of heritabilities were reported for the abundance of microbial community (i.e. the abundances of the identified specific microbes) in dairy cows in the range from 0.08 to 0.62 (Saborío-Montero et al., 2020; Cardinale and Kadarmideen, 2022). The magnitude of genetic correlation of the microbiome composition depends strongly on the extent to which the trait of interest is part of the heritable microbiome and involved in metabolites required for production of methane. Martínez-Álvaro et al. (2022) found that among the heritable part of the rumen microbiome, a greater number of microbial genes had a stronger genetic association (genetic correlations with absolute values in the range from 0.59 to 0.93) with methane emissions than the abundance of specific microbes (115 vs. 29). **This indicates that the composition of the microbial genes in the rumen is the most informative microbiome characteristic to breed low methane emitting cattle without its extremely costly measurement of methane emissions.** These microbial genes carried by bacteria, protozoa and fungi were involved in specific metabolic processes associated with the essential microbial fermentation of feed to provide most of the energy and protein for the animal to produce meat. Based on our results, we proposed a selection index based on the abundances of the 30 most informative microbial genes to reduce methane emissions, in the following referred to as *microbiome-driven breeding* strategy.

Figure 2: Low methane emitters showed substantially lower relative abundances of the microbial gene fwdA involved in methane metabolism in comparison to the high methane emitters (same trial, breed, diet, feed Intake, rearing and husbandry; Roehe et al., 2016)



Potential selection response

Our research as collaboration of SRUC with Genus plc and the University of Edinburgh has shown that the use of the abundances of the 30 most informative microbial genes in the *microbiome-driven breeding* strategy was highly efficient. When rumen *microbiome-driven breeding* is used intensively for methane mitigation in a cattle population, we predict based on data from experiments carried out at the SRUC Beef Research Centre, a reduction in methane emissions of up to 17% per generation. The *microbiome-driven breeding* strategy uses genomic selection to estimate the breeding values of methane emissions and could therefore result in a reduction of the generation internal to 2.5 years and thus result in an annual reduction in methane emissions by up to 7% per year. *Microbiome-driven breeding* can also be used to simultaneously improve the efficiency of cattle converting feed to meat and thus reducing the carbon footprint of beef and increasing the profitability of production (Lima et al., 2019). Preliminary analysis of the SRUC data suggest that selection on the abundances of 30 specific microbial genes genetically linked the feed conversion ratio can improve feed conversion ratio by up to 15% per generation. In addition, abundances of newly identified microbial species as obtained by Stewart et al. (2019) based on metagenomic sequences of ruminal microbial content from SRUC experimental cattle, could be used in *microbiome-driven breeding* to further reduce methane emissions or to improve animal health characteristics (e.g. prevention of ruminal acidosis) associated with the rumen microbiome. Our research also suggests that *microbiome-driven breeding* and dietary intervention are additive mitigation strategies and therefore can be efficiently combined to reduce methane emissions from cattle.

Conclusions

Microbiome-driven breeding is a highly promising new technique to produce climate smart efficient beef cattle. However, as any selection strategy, it needs a specific breeding programme where AI is highly present, cattle are genotyped using a SNP chip and rumen samples are taken from individual animals to determine the rumen microbiome. As our research has shown, if these requirements are provided, large changes in methane mitigation and improvement of feed efficiency can be achieved to obtain climate smart efficient cattle.

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Fertility, efficiency and sustainability of dairy herds

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Introduction

The UK Dairy Industry, like other livestock sectors, faces pressures from increasing global demand, negative publicity about animal production, competition for land to grow animal feed versus human food, rising input costs, and concerns about environmental emissions. To address these issues, producers should aim to make more efficient use of resources, which calls for an increase in production efficiency whilst reducing environmental impact.

This paper will examine measures of production efficiency and show how they are influenced by fertility of dairy cows. A central feature is that fertility affects efficiency through premature culling, which lowers lifetime performance and increases the number of replacement heifers that need to be reared.

Production efficiency

Production efficiency is the ratio of milk output to feed input, and can be increased by increasing milk yield, reducing feed intake or a combination of the two. A cow with a higher milk yield is biologically more efficient than a cow with a lower milk yield when fed on the same diet and with the same live weight. This is because, although the high-yielding cow has a greater dietary energy requirement for milk production, maintenance requirements are the same for both cows, so the high-yielding cow partitions a greater proportion of her energy intake to milk production. For example, a cow yielding 10,000 litres of milk per annum partitions 69% of her energy intake to milk production, whereas a cow yielding 4,000 litres of milk per annum partitions 46% of her energy intake to milk production. A different way of stating this is that the higher-yielding cow spreads her maintenance requirements over more litres of milk, so is more efficient.

For a group of cows, milk yield per cow determines the number of cows required for a given level of milk production. To produce one million litres of milk per annum, for example, requires 250 cows averaging 4,000 litres per annum or 100 cows averaging 10,000 litres per annum. In this comparison, one million litres of milk involves maintenance requirements for either 250 or 100 cows. Again, higher-yielding cows spread maintenance requirements over more litres of milk, so production efficiency is greater.

Production efficiency, based on milk yield, is not always the same as resource efficiency (e.g. land use) or economic efficiency (i.e. profit). There are clear benefits from using lower-yielding cows in grazing systems, especially where they produce higher milk solids yield per hectare of grassland. In this case, production efficiency would be the ratio of milk solids output to feed input.

Milk yield and fertility

The strong relationship between milk yield and production efficiency encouraged cattle breeders to select mainly on milk yield for many decades of the last century. This was particularly seen in North American Holsteins, where elite bull mothers were often produced by embryo transfer from the very highest yielding cows, and then superovulated to produce the next generation of cows and bulls. Globalisation of cattle genetics enabled widespread use of semen from these bulls to provide rapid gains in genetic merit for milk yield. According to Defra statistics, average annual milk yield per cow in the UK increased from 4,000 litres in 1973 to 6,000 litres in 2000.

Unfortunately, focus on milk yield as a single breeding goal led to a progressive decline in genetic merit for fertility in Holstein cows. The problem was exacerbated in the UK by challenges in meeting increased nutrient demands of high-yielding cows from traditional feed resources, leading to metabolic stress and poor reproductive performance. The fertility decline was highlighted by a study at the University of Nottingham, which showed that pregnancy rate to first service had declined from 56% in the 1970s to less than 40% in the 1990s, accompanied by an increase in atypical ovarian hormone patterns (Royal et al., 2000).

Fertility and replacement rate

Failure to get in calf is the main reason for involuntary culling of dairy cows worldwide (Dallago et al., 2022), and can account for up to 50% of culls (Esslemont and Kossaibati, 2002; Brickell and Wathes, 2011). In a survey of 18 dairy farms, Brickell and Wathes (2011) found that 19% of cows were culled in Lactation 1, 24% were culled in Lactation 2, and only 55% of replacement heifers calved for a third time.

Poor fertility is a major determinant of replacement rate because cows culled prematurely have to be replaced to maintain herd size and milk output. Oestrous detection rate and conception rate affect the number of cows that get pregnant and avoid culling for fertility. These factors were modelled in the study of Garnsworthy (2004). An oestrous detection rate of 50% and conception rate of 38% resulted in a replacement rate of 35%, which concurred with national statistics. Improvement of oestrous detection to 70%, or conception rate to 55%, resulted in a replacement rate of 25%; improvement in both factors reduced replacement rate to 20%.

Replacement rate is the inverse of survival, so herds with a replacement rate between 25 and 33% cull cows in their third lactation on average. Recent data from NMR statistics for 2021 found average replacement rate was 28% and cows exited at 3.5 lactations (Hanks and Kossaibati, 2021).

Fertility and efficiency

Annual milk yield per cow increases over the first three lactations and reaches a plateau. In their first lactation, cows typically yield only 70 to 80% of their mature milk yield because they divert some nutrients towards growth rather than milk. Furthermore, economic costs of rearing are not repaid from milk income minus fed costs until approximately half way through the second lactation (Boulton et al., 2017). Premature culling due to infertility means that cows do not reach their potential milk yield and profitability, so efficiency is low.

Even if a cow is not culled for infertility, low fertility can affect efficiency. A cow with good fertility can have four lactations in the first four years of life in the milking herd. A cow with average (low) fertility will only have three lactations in four years. The cow with good fertility will produce 27% more milk in her lifetime for an increase in energy intake of only 12%, so feed efficiency is increased by 8%. Furthermore, methane emissions per litre of milk are reduced by 13%. Basically, the cow with good fertility spreads feed inputs and methane outputs incurred during the rearing period over more litres of milk in her lifetime.

At the herd level, a higher replacement rate means that more heifers have to be reared, so more feed is required. Feed required for replacement heifers also increases if age at first calving is greater than the target of 24 months. Over a range of 20 to 45% replacement rate and 24 to 36 months age at first calving, feed energy required for replacement heifers varies from 16 to 44% of total feed energy required for the whole herd. Fertility, therefore, affects feed efficiency of the whole farm.

Under the Research Partnership between Nottingham University and AHDB Dairy, a project was conducted to quantify whole farm feed efficiency (WFFE) over the range of UK dairy systems (Garnsworthy et al., 2019). Whole farm feed efficiency was defined as annual milk production divided total feed dry matter produced or purchased for all dairy animals, including milking cows, dry cows and youngstock. Farms were classified into five systems according to number of months cows spent grazing each year. System 1 farms grazed cows for >9 months; System 2, 6–9 months; System 3, 3–6 months; System 4, 0–3 months; and System 5 farms housed cows all year. Detailed data were gathered by visiting 21 dairy farms quarterly for one year, and more widespread data on feed use and economics were gathered by adding questions to the National Farm Business Survey for 300 dairy farms.

Average WFFE increased as grazing time decreased across systems, ranging from 0.99 for System 1 farms to 1.13 for System 5 farms. This was expected because there is less control over feed supply when cows are grazing than when they are housed. Within each farming system, however, there was considerable variation. Ranges in WFFE for individual farms were 0.5 to 1.3 in the detailed survey, and 0.2 to 1.5 for the National survey. There was a strong relationship between WFFE and gross margin per hectare.

The main driver of WFFE in both surveys was milk output per hectare, which was a function of stocking rate, milk yield per cow and grass/forage quality. Feed wastage or feed underutilisation was another important driver. Of the animal management and health factors, the biggest single driver was proportion of cows culled for fertility, followed by age at first calving. Reducing fertility culls from 40% to 20% would improve WFFE by 15%.

Sustainability

Although most people think of sustainability only in the context of environmental impact, sustainability has three pillars – environment, society and economics. An enterprise is only sustainable if it does not unduly affect the environment, is socially acceptable, and returns a profit. Improving fertility has positive effects on all three pillars.

According to the UK greenhouse gas (GHG) Emissions Inventory, agriculture accounts for 9% of total emissions, and dairy accounts for 27% of agricultural emissions or 2.4% of total emissions. The substantial carbon sequestration by grassland, trees and hedges on dairy farms is not credited to agriculture, but is in the category of land use, land use change and forestry. Carbon sequestration within animals, which can be for up to ten years in dairy cows, does not feature in emissions calculations. Overall, therefore, dairy makes a small contribution to UK GHG emissions compared with emissions by the energy sector. Nevertheless, all sectors have to aim for reductions in GHG emissions.

According to FAO, dairy emissions comprise feed carbon footprint (46%), enteric methane (39%), manure management (10%), and farm energy use (5%). By improving fertility, and thereby reducing replacement rate and increasing feed efficiency, GHG emissions can be reduced from all sources, with the possible exception of farm energy use (e.g. electricity for milking and refrigeration, fuel for machinery).

Improving WFFE by reducing replacement rate will have obvious benefits on feed carbon footprint because less feed will be required per litre of milk. Lower methane emissions from a cow with good fertility (13%) are discussed above. Reducing replacement rate through improved fertility will have an even greater effect on methane emissions by a whole herd because fewer replacement heifers are required. Herd replacements emit up to 27% of herd methane emissions, and improvements in fertility could reduce methane emissions by up to 24% (Garnsworthy, 2004). Similar improvements can be expected for reduced ammonia, nitrogen and phosphorus excretion.

An indirect route by which the dairy industry benefits national GHG emissions is through dairy beef. It is estimated that approximately 50% of UK beef originates in the dairy herd, either from cull cows or from dairy cross beef calves that are raised for beef production. Carcasses from calves originating in the dairy herd have one third of the carbon footprint of calves originating in the beef herd (Opio et al., 2013). This is because in the beef suckler herd impact of breeding animals is allocated to beef, whereas in the dairy herd impact of breeding animals is allocated to milk. Reducing replacement rate through improved fertility will lower the number of cull cows available for beef, but this will be more than offset by increased numbers of dairy cross beef calves available for fattening into prime beef.

Genetic improvement

Identification of the decline in cow fertility up to the 1990s provided a stimulus for developing a genetic index for fertility. The Fertility Index was introduced in 2005 and has led to steady improvement in genetic merit for fertility whilst genetic merit for milk production continues to improve (Winters, 2022).

Heifer replacements should have the highest genetic merit in the herd. Theoretically, culling cows in Lactation 3 provides faster genetic gains than keeping them until Lactation 4. As discussed above, however, cows culled in Lactation 4 have greater lifetime efficiency than cows culled in Lactation 3. Furthermore, it is often the highest yielding cows that are culled early, and there may be little opportunity to cull low yielding cows. These conflicting drivers were modelled by De Vries (2021) who concluded that the optimum lactation to balance culling trade-offs was the Lactation 4.

Another consideration related to genetic improvement, is how many heifer replacements are produced by each cow. Under normal circumstances, with a three-lactation herd life, a cow would produce 1.5 bull calves and 1.5 heifer calves. There will be some losses among heifers, and we might expect 80% pregnancy rate, 5% calf mortality, and 5% other losses. Given these losses, the cow produces a total of 1.08 heifer replacements – she only just replaces herself. This leaves little scope for genetic selection apart from which bull to use.

Development of sexed semen has been a game changer for producing female replacements. Early attempts were disappointing, but the latest technology produces about 90% female offspring, although sexed semen may reduce conception rate by 10%. Instead of producing 1.08 heifer replacements in three lactations, sexed semen would result in 1.95 heifers per cow. Sexed semen allows producers to breed replacements from the best heifers and cows, and to produce dairy cross beef calves from inferior cows. According to AHDB statistics, sexed semen was used for 70% of dairy inseminations in 2021/22.

Sexed semen does not overcome effects of fertility on replacement rate, WFFE and methane emissions from cows and dairy replacements. In fact, reduced conception rate with sexed semen might increase replacement rate and reduce WFFE. However, overall sustainability of dairy plus beef production is likely to be improved by using sexed semen.

Conclusions

Poor fertility in dairy herds results in premature culling of cows, lower lifetime performance, less opportunity for genetic selection, and increased replacement rate. Increased replacement rate means that more heifers have to be kept on the farm, consuming feed and contributing to environmental impacts.

The optimum lifetime of cows is four lactations, which provides the best balance between lifetime milk yield, spreading rearing costs, and genetic improvement. The majority of cows, however, are culled before their third lactation, and failure to conceive is the main reason for culling.

Improving fertility is a win-win strategy that increases resource efficiency, feed efficiency, and all aspects of sustainability.

Acknowledgements

Background research that informed this paper was funded in several projects by MAFF, DEFRA, LINK, DairyCo, AHDB Dairy and industry partners.

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Reducing feed costs and lowering methane emissions

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As a breeding company CRV wants to gain insight into the differences between animals and rations. With the knowledge from our studies, new solutions are developed that enable livestock farmers to improve feed efficiency of the herd and control methane emissions. An important starting point here is the efficient use of feed, or feed efficiency. This can save an average of 10% on feed costs.

Feed costs are about 60% of all variable costs to produce milk. Therefore, it is important to breed efficient cows that make better use of their feed to produce milk. In addition, more efficient use of feed also has a positive effect on the environment by reducing greenhouse gas emissions and requiring fewer scarce resources.

As the first breeding organisation in the world, CRV invested in 2017 in collecting feed intake data from individual cows on commercial dairy farms. Since then, other breeding organisations have also become aware of the fact that feed efficiency will become increasingly important and have therefore also taken initiatives to be able to measure feed intake. So far, however, only on a limited scale.

10,600 feed intake data a day

Every day, CRV collects 10,600 feed intake data from lactating cows. This is done on 5 commercial and 5 research farms. It involves data from a total of 2,500 cows. The goal is to reduce feed costs for milk production by selecting cows with better feed efficiency.

Cows with high feed efficiency need less feed per kg of fat and protein corrected milk. On every farm, there is a lot of variation in feed efficiency between cows. There are cows that need 1 kg dry matter feed to produce 1 kg FPCM milk and there are cows that need only 1 kg dry matter feed to produce 2 kg FPCM milk. The 25% best cows for feed efficiency in the herd need a quarter less feed for the same amount of milk than the 25% least feed efficient cows. This means less feed and therefore less manure, but also less methane.

Big impact on the profitability of a dairy farm

With all this data, breeding values for feed efficiency are calculated. The highest bulls have a breeding value from 108 to 112 for feed efficiency. When bulls with an average of 108 feed efficiency are used, the daughters of these bulls will produce 4% more milk with the same amount of feed or require 4% less feed for the same amount of milk. On a dairy farm with 200 cows and an average milk production of 10,000 kg of milk, this gives extra milk income of €40,000 a year at a milk price of 50 cents.

Feed efficiency breeding value with high reliability

The collected feed intake data has already led to a reliable breeding value for feed efficiency. This has been calculated since December 2020. With the index run of December 2022, CRV already has 10,000 cows with feed intake data and therefore the largest reference population when it comes to feed intake data from individual lactating cows. On the 10 farms where the feed intake is measured, they are mainly daughters of CRV bulls. This means that the current proven bulls already have large numbers of daughters with feed intake data. This results in a breeding value for feed efficiency with high reliability for the proven bulls (see Table 1 below).

All the collected data is included in the reference population and ensures a reliability for feed efficiency by the young genomic bulls for about 50% and thus already gives a good prediction of the feed efficiency of the future daughters. In the coming years, the number of cows with feed intake data will only increase and with it the

Table 1: Current CRV proven bulls with reliable feed efficiency breeding values

Bull	*Number of daughters*	*Breeding value Feed Efficiency (FE)*	*% reliability FE*
W. Esperanto	73	110	80
D. Lendor	69	106	75
B. Final	64	103	82
D.W. Ranger	99	102	77
D.Jupiler	164	102	82
D. Magister	141	101	82
Rocky	52	95	80

reliability. Through selection in CRV's breeding program, almost half of the bulls have a feed efficiency breeding value of 105 or higher.

Research on methane

In addition to the data collected by CRV on feed efficiency a lot of research is being done on methane emissions. To do so, CRV has 3 projects running:

- Measuring methane emissions on a feed intake test farm using Greenfeeds.
- Measuring methane emissions on about 100 farms with a total of 15,000 cows using sniffers.
- Research at young AI bulls using Greenfeeds to measure methane emissions.

All this data from the 5 feed intake farms and methane measurements provides an important contribution to the overall research into methane emissions. Methane emissions are expected to play an even greater role in the future.

Reliable breeding value methane in 2025

Research has taught us that methane emissions from cows are about 30% heritable. We also see large differences between cows averaging 320 grams of methane per cow per day with a variation of 250 to about 400 grams per day. By breeding now with those animals that produce less methane, we expect to be able to reduce total methane emission by 1% per year. That doesn't seem much, but by 2050 that will be 25% less methane emissions. It is expected that this will result in a reliable breeding value for methane emissions by 2025.

How can the Economic Breeding Index (EBI) help us to achieve our breeding aims?

Rhys Davies
Dairy Farmer, Holywell, Flintshire

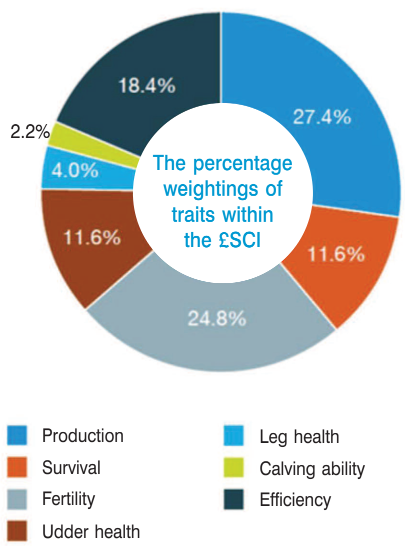
Background

My family and I farm just under 150 acres in Holywell, Flintshire where we milk over 100 spring calving herd of Black and White cows along with 80 followers. We aim to calve as many within 9 weeks from the 1st March to the beginning of May, with empty cows culled or carried over and sold as fresh calvers in Mold market during the late summer months. In the past we have operated an all year round and autumn calving system based on grazing, but since 2008 we have operated a spring calving system and now supply Arla on a manufacturing contract. I have been interested in our herd's genetics since we registered our first pedigree cow back in 1983 and have milk recorded for over 35 years allowing us to look back on nearly ten generations worth of information. Holstein blood has played a large part in our herd for many years and myself and my father still look for balanced cows with width throughout, correct mammary systems and excellent locomotion. During the transition over to a grass and block calving system we soon found out that the mainly North American origin Holstein breed in the herd lacked in terms of fertility, milk solids and condition score.

Therefore, we introduced Black and White genetics from New Zealand along with some Irish and Dutch Holstein Friesian. These matings resulted in a much more suitable cow for the system. This was then followed by the dawn of the Genomic era which widened the choice of Black and White bulls even further. Despite this, there is still a huge variation in the herd from the high yielding Holstein type to the smaller NZ Kiwi cross.

In the UK the main Index to help farmers select and breed for profitable cows is the £PLI (Profitable lifetime Index) which for years was the only Index available to rank bulls and cows on regardless of the system you operated. In 2014 AHDB Dairy launched the £SCI (Spring Calving Index) and in Summer 2018 launched the £ACI (Autumn Calving Index). All three systems are to complement AHDB's optimal dairy systems strategy. Currently we use three Indexes to help choose bulls and select cows for matings – The £PLI, £SCI and $BW (Breeding Worth – New Zealand dollar). See Figure 1 below.

Figure 1: Emphasis on different traits within the Spring Calving Index (£SCI)



History and make-up of the EBI

The EBI was introduced in 2001 to replace the RBI (Relative Breeding Index) which was primarily made up of production traits including Kg Milk yield which led to many foreign sires populating the top ranks of each proof run with their converted data and not based under actual Irish environmental conditions. With the formation of the EBI, a greater emphasis was placed on other economic traits of importance such as fertility and milk solids, especially protein. Other notable aspects of the EBI are the inclusion of beef characteristics which has helped increase cull cow values and allowed the beef cross industry to benefit without compromising the total amount of KgMS produced. Table 1 on page 40 shows relative emphasis of different traits of the EBI.

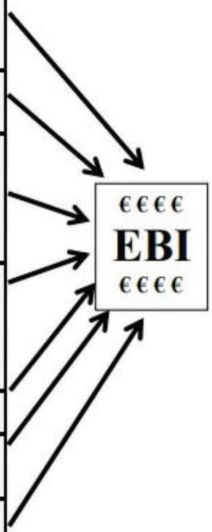
Each €1 gain in a Herd's average EBI is worth €1.96 per cow per lactation in terms of net profit. For a 100 cow herd with a €150 EBI over a same sized herd with a €50 EBI average, this would be equivalent to an additional €19,600 profit.

Study tour to Ireland

In October 2018 I travelled to Ireland and embarked on a 4 day tour of Irish dairy herds. The reason I wanted to visit Ireland was not only to see the type of Black and White cow the Economic Breeding Index (EBI) was producing but also how the industry fed data into the genomic and daughter proving system along with any research carried out to underpin the Index. Ireland has very similar conditions to Wales in terms of topography and climate with an ability to

Table 1: Relative emphasis of the main sub-index traits on the overall EBI

Sub-Index	Trait	Economic Weight	Trait Emphasis	Overall Emphasis
Production	Milk	-€0.09	10.6%	33%
	Fat	€1.04	3.4%	
	Protein	€6.64	18.9%	
Fertility	Calving Interval	-€12.43	24.0%	35%
	Survival	€12.01	10.9%	
Calving	Direct Calving Difficulty	-€3.52	2.8%	9%
	Maternal Calving Difficulty	-€1.73	1.3%	
	Gestation Length	-€7.49	4.1%	
	Calf Mortality	-€2.58	1.0%	
Beef	Cull Cow Weight	€0.15	0.7%	9%
	Carcass Weight	€1.38	5.1%	
	Carcass Conformation	€10.32	1.7%	
	Carcase Fat	-€11.71	1.1%	
Maintenance	Cull Cow Weight	-€1.65	7.2%	7%
Management	Milking Time	-€0.25	2.1%	4%
	Milking Temperament	€33.69	1.9%	
Health	Lameness	-€54.26	0.6%	3%
	SCC	-€43.49	1.8%	
	Mastitis	-€77.10	0.8%	



grow grass with a strong emphasis on processing for cheese and other products. Eighty five percent of Irish dairy herds operate on a block calving grass based system therefore the main focus has been on breeding a suitable cow for that particular system. Many of the available bulls for grazing in the UK studs are also Irish bred.

Key findings of the tour were:

- Close links between all industry partners – less friction than UK (or so it seems)
- Genetic indexes backed up with focused research at Teagasc
- An index not dictated by big AI companies and topped by foreign bulls with converted proofs
- One system approach as an industry
- EBI held well post quota abolition
- Cull and beef cross calves an important aspect of EBI make up
- Focus always on efficient grass utilisation
- High EBI cows are moderate sized, get in calf easily and have high milk solids
- Possible to breed Black and White cows with Jersey like solids and crossbred like fertility
- Through widespread Genotyping of bull calves, ICBF improving all herds not just EBI focused herds as High EBI sweeper bulls and cheap elite young bulls used almost unknowingly by the more commercially minded farmers
- Lifestyle important to all farmers and that the cow should work for them, not the other way round.

Next steps

The exchange opened my eyes and further reinforced what I suspected we needed to improve not only on the type of cow but also on how we manage her and the herd as a whole.

1. *Tighten the calving block and front load B&W sires* – One of the first things that needs to happen is to stop any cows calving to Black and White bulls after the nine weeks – too many females are kept as replacement from these later calving cows furthering their legacy of compromised fertility. Culling of these cows should be considered either as barren cows or sold as fresh calvers during May and June. Not only will this improve the management of fresh and early lactation cows it will also ensure lower fertility is not inherited into the herd.

2. *Choose one Index to select bulls* – or ensure Indexes are converted as accurately as possible to the index of choice. Use Clarifide genomic interpretation tool to develop a 'Moor Farm Spring Calving Index'.

3. *Use selection tools to rank females in the herd* – i.e Calving Interval, Total KgMS/Cow, KgMS/KgLW and KgMS/Day. This should replace yardsticks for selection such as Milk Kgs, Classification scores and on who the dam and grand-dam was.

4. *Identify an elite group of genomically tested heifer calves* – from cows with good fertility records and milk solids and track progress against other groups of animals.

5. *Incorporate flat rate feeding in the parlour* – the current feeding regime of concentrate leads to variability in intakes and on a dry year like this year, lighter and younger animals have not had their full allocation of dry matter leading to some issues with lower BCS than normal. New parlour feeders to be considered.

Conclusion

The Exchange started off as being an opportunity to look at what sort of cows the EBI was responsible for breeding, however I quickly realised the EBI was a result of much wider Industry integration that was also partly driven by government department policies. The work of Teagasc is also important in facilitating effective research and focused KT, this none more evident than in the quick and effective response by the exchange farms Teagasc advisors in my assistance for which I am very grateful. All farmers along with the institutions that I visited were very open about their farming business and were more than happy to engage in frank and open discussions which is as refreshing to see as it is informative. Without this openness the exchange outcomes wouldn't have been achieved. Again, this lateral industry co-operation has also been key to the success of the EBI.

It is also very apparent that individual breed societies, the showing circuit and AI companies have much less sway in Ireland compared to the UK, allowing breed development to be focused on feed efficiencies, animal health whilst also being linked to overall farm profit.

Lastly, on the high EBI cow herself, she is a no fuss, 550 kg moderately sized functional Black and White animal capable of achieving 5000–8000 kg+ on mainly grass and limited concentrate whilst easily achieving 9% solids. She displays strong early heats and gets back in calf quickly with only one service after transitioning seamlessly from the dry period to early lactation where she holds condition during the often interchangeable weather at turnout. She's a cow you can see over, but not under her with a wide muzzle and deep capacious body which allows for high grass dry matter intakes which leads to efficient conversion of grass to milk. At the same time large volumes of milk is being held hygienically in a functional well attached udder where she goes on to milk out quickly before moving easily and freely back to the grazing paddock. Using her slightly sickled leg set with plenty of flex in the pastern and good depth of heel for excellent locomotion to ensure a lameness free lactation regardless of walking surface. And when she finally does reach the end of her time on the farm, often approaching her tenth lactation, she is still fit and well fleshed enough to further increase profits for her owner's farm.

Acknowledgments

George Ramsbottom – Teagasc, Farming Connect Management Exchange Team and all host Farms and ICBF.

View Rhys Davies full Farming Connect Management Exchange report at rhys_davies_report_management_exchange_–_impact_of_ebi_v2_0.pdf (gov.wales)

Resilience through crossbreeding

Sean Chubb and Tom Moore
Lead pasture to profit consultant LIC and Walford College Farm Manager

In 2019 Walford college merged with Hereford and Ludlow colleges to make North Shropshire college. In the same year Tom Moore became farm manager and was given the clear instructions the farm needed to be promoting best practice, high animal welfare and to break even financially. Tom didn't feel that breaking even was best practice so set his sights on making the college farm as profitable as possible.

After looking at the financial performance of the farm in 2018 Tom knew that changes had to be made and quickly if he had any chance of making the farm break even let alone profitable. In 2018 the farm had lost £442,452, costs were high across all categories but purchased feed, bedding and machinery costs were exceptionally high. These costs were driven by forage quality and from this poor milk from forage (it was 985 in 2018), this resulted in large amounts of concentrates being fed. The dry and calving cows were housed in loose housing that were bedded up with straw, in 2018 the straw prices were high which helped to push the bedding costs so high. With all the machinery that was owned to undertake feeding, land care, slurry application, scrapping up, bedding and planting, the machinery costs were too high for this to be of any benefit (see Table 1).

Meeting the high animal welfare and best practice was also going to be an up-hill battle, with the rearing of the calves being the biggest issue. With no purpose-built building to rear the calves, they had been reared in various buildings on the farm like the old parlour. As these buildings were not designed with the required air flow for calf rearing, the calves suffered with high mortality rates.

Table 1

Output	*£*	*p/l*
Milk	394,864	25.70
Stock sales	67,603	4.40
Other dairy income (excluding subsidies)		0.00
Inventory change (automatically calculated)	83,000	5.40
Total Output	**545,467**	**35.50**
Variable Costs		
Livestock Purchases		0.00
Purchased Feed		
Total	**281,168**	**18.30**
Forage Variable Costs		
Fertiliser	18,437	1.20
Lime		0.00
Seeds and sprays	15,364	1.00
Additives, plastic	1,536	0.10
Total	**35,337**	**2.30**
Livestock Costs		
Vet & Med	52,238	3.40
Breeding, AI and Recording	23,046	1.50
Livestock sundries	13,827	0.90
Bedding	121,378	7.90
Parlour – Consumables		0.00
Parlour – Service and Maintenance		0.00
Total	**210,489**	**13.70**
Total Variable Cost	**526,994**	**34**
Overheads		
Power and Machinery		
Repairs and Spares	75,285	4.90
Fuel and Oil	23,046	1.50
Electricity	10,755	0.70
Tax and insurance (for power and machinery)		0.00
Contractors: silage/forage		0.00
Other contractors	44,556	2.90
Total	**153,642**	**10.00**
Labour		
Paid	156,716	10.20
Unpaid (£30,000 per full time labour unit)	0	0.00
Total	**156,716**	**10.20**
Depreciation and Leasing		
Plant, machinery, vehicles	44,556	2.90
Buildings	21,510	1.40
Machinery leasing		0.00
Total	**66,066**	**4.30**

Table 1 continues on next page

Sundry Overheads		
Water	9,218	0.60
General insurance	16,900	1.10
Office, phone and bank charges		0.00
Council tax	12,291	0.80
Advice and professional fees	9,218	0.60
Subscriptions		0.00
Miscellaneous	24,583	1.60
Total	**72,210**	**4.70**
Repairs land and buildings	12,291	0.80
Total Overheads	**460,925**	**30.00**
Total Operating Expenses	**987,919**	**64.30**
Cash cost (excl. depreciation and unpaid labour)	**921,853**	**60.00**
Comparable Farm Profit (CFP)	**−442,452**	**−28.80**

The feeding of the heifers post weaning was not giving them a balanced diet for growth and development, the effects of this can be seen through the breeding records for the farm. Each year the number of heifers that were mated >16 months of age was too high, with the average age at first calving peaking in 2017 at 29.9 months of age (see Table 2).

With a range of soil types, the farm can grow good levels of grass through the year and is suitable for growing maize which it has done, making the farm self-sufficient in its forage needed. The issue was that management of these forages resulted in poor quality silages. When coupled with the poor rearing of the heifers, the cows were limited in the level of production that they could produce. This saw the farm only being able to produce an average of 8344L/cow with a range of 7600L/cow to 9000L/cow, well below the genetic potential of the cows and what would be expected for the level of concentrates being fed (see Table 3).

Knowing that improvements needed to be made quickly for the college farm to remain, Tom drew on his prior farming background knowledge to formulate a plan to improve the situation. He proposed that the college turns the cows out to grass and move the system to an autumn calving block. The college backed this plan with the only stipulation being that the current herd remains and the future breeding retained a black and white cow, with a new principal instated in 2020 these rules were relaxed.

The plan for improving the financial performance of the farm focused on cutting costs as well as increasing the income. Through turning the cows out and targeting 9 to 10 months of grazing, the farm will be able to lower the amount of purchased feed along with the requirements for silages to be grown and made. The goal is to get the concentrate use down one tonne per cow through maintaining good grass quality year-round and make high quality silages. Another measure for success here would be to achieve 6000L from forage. The creation of the autumn block will better match the grass growth on the farm with the demand from the cows as well as giving the herd uniformity in their dietary requirements. At the beginning of the transition the average age of the herd was 2.3 years, the aim is to increase this steadily up to the target of 4.5 years, to achieve this the heifers needed to be properly grown when they enter the herd and target 95% of them making it through to the second lactation. Luckily the creation of the block and turning the cows out freed up the dry cow shed to be used for calf rearing which has fixed the calf mortality issue.

The farm was originally supplying Müller on a white-water contract with a slight bonus or penalty around the percentage of fat. At the beginning of the transition, this milk contract was one of the lowest paying on the market. With this milk contract, maintaining milk production through the transition was important to

Table 2

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*
Age at 1st insemination (months)	14.8	15.8	15.7	14.8	18.0	16.2	19.6	17.9	14.5	16.1	16.8	14.2
Number of young stock not served >16 month	42	49	38	37	58	49	53	85	36	39	38	17
Expected calving age heifers	24.3	25.3	24.7	24.6	27.1	26.1	29.7	28.4	25.3	26.1	25.9	28.4
Average age at first calving	25.8	24.9	25.9	26.2	27.5	28.6	26.8	29.9	28.1	25.5	26.4	25.4

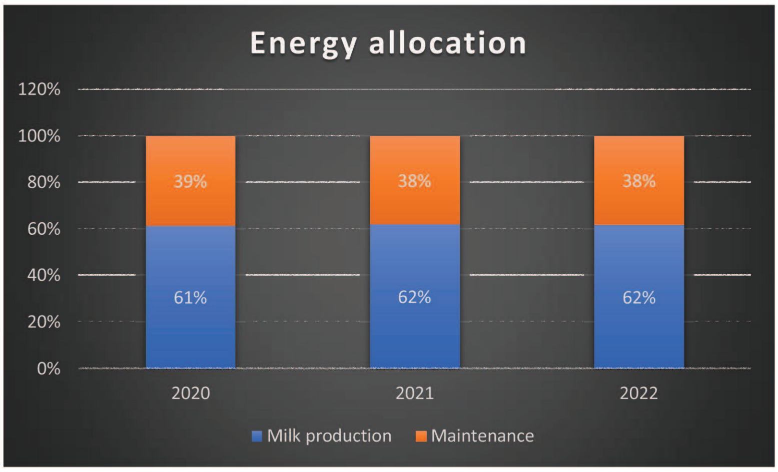
Table 3

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*
Milking Herd												
Total cows in herd	126	143	193	219	224	216	225	216	214	153	140	153
Average 305 days production milk	8050	8580	8357	8612	8707	8509	7621	8594	8421	9018	7635	8022

minimise any loses. Changing the milk contract to one that would see a greater value per litre was needed, the aim was to get onto a milk solid based contract as this wouldn't result in less income if litres were exchanged for higher solids. As the farm was unable to obtain a solids-based contract through Müller, they have now changed to Helers cheese. To be able to make the most of changing the milk contract, the percentage of fat and protein in the milk needed to increase, the breeding would need to change to achieve this.

To be able to achieve the goals stated above, the type of cow being farmed needed to change. To be able to maintain grass quality with minimal mechanical intervention, the cows need to be effective grazers. Despite the Holsteins proving that they can be trained to achieve constant residuals of 1500KgDM, they were not able to graze above 15KgDM of grass per day without becoming unsettled. So, to be able to get more grass into the diet, grazing cow genetics were needed. This need for grazing genetics was also highlighted in the first summer of grazing when the fat % in the milk dropped to 3.3%, the Holsteins were affected more by the waxy coating on grass, meaning they cannot access the fibre as easily. As cows are limited to 18KgDM of grazed grass intake in a day irrespective of the breed, the maintenance requirements of the cows needs to be as low as possible to enable the maximum energy to be put towards milk production. The Holsteins in the herd averaged around 680 kg, meaning their maintenance requirements were 78MJME, if the cows had met their genetic potential their maintenance could have been as high as 85MJME. The target is to reduce the herd size down toward 550 kg, this would reduce the maintenance requirements to 65MJME. This means 2 litres worth of energy is no longer going towards maintenance and can be put towards milk production. With the furthest paddock being 1km away from the parlour, the cows would need to have feed and legs that can withstand the requirements of walking to and from the parlour twice a day. To lift the fat and protein levels, this needed to be a key selection criteria for the selection of bulls along with fertility to be able to retain a tight block (see Figure 1).

Figure 1



Through crossbreeding these gains will be maximised from the hybrid vigour that will be obtained. When breeding within breed, the potential of the heifer is taking half of the cow and half of the bull's traits, but when you are crossbreeding the parent traits are increased by the below factors.

Table 4

Trait	Impact of Hybrid Vigour
Milkfat	+4.7%
Protein	+4.6%
Milk Volume	+4.2%
Live Weigth	+2.1%
Cow Fertility	+5.2%
Somatic Cell Count	-4.1% (favourable)
Days of Herd Life	+13.5%

To be able to receive 100% of these benefits from hybrid vigour, the cow and bull need to be of different breed e.g 100% Holstein cow and 100% Jersey bull. Breeds like Ayrshire and Holstein are closely related so the level of hybrid vigour is going to be less. Research in New Zealand around grazing cows found that the best cross was between New Zealand Jersey and Holstein Friesian, Jersey's and Ayrshire's are genetically further apart but the lower production figures of the Ayrshire's negated the slightly higher level of hybrid vigour.

With the breeding stipulations placed on the farm around maintaining a black and white herd, the opportunity to obtain hybrid vigour was reduced. The bulls used in the first year were hammer and Kelsbells both of which are F15J1 breeding along with Sierra F11J5 and Beaut F9J7, as the New Zealand Holstein Friesians are 8 generations or greater removed from the breeding historically undertaken at Walford, this meant that each bull would provide some degree of hybrid vigour (see Table 5 on page 45).

In 2020 with the change of the principal, the farm was open to using any breed. The Jersey bull integrity J16 was used for the first time over the Holsteins, this bull brought 5.9% fat and 4.3% protein, longevity and low live weight. The benefit for the heifers from this breeding is that no matter which bull is used on them there will be 50% hybrid vigour, this allows for a wider selection of bulls to obtain the type of cow that is being targeted on the farm.

The move to a grazing autumn block system has proved to be the right decision for profitability, the results from the breeding is only in its first year with the first lot of LIC bred heifers entering the herd in 2022.

Table 5

	Dam (breed 16ths)				
Shire (breed 16ths)	F16J0	F12J4	F8J8	F4J12	F0J16
F0J16	100	75	50	25	0
F4J12	75	63	50	38	25
F8J8	50	50	50	50	50
F12J4	25	38	50	63	75
F16J0	0	25	50	75	100

These heifers have calved down around 580 kg meaning they will likely reach a mature weight of around 640 kg. This is not much below where the herd was originally, but this is due to the cows not meeting their genetic potential.

From the milk recording data taken so far this year, the heifers are outperforming the herd on fat and protein percentages, the heifers are averaging 4.38% fat and 3.33% protein with a range of 3.36% to 5.87% for fat and 2.77% to 3.8% for protein whereas the average for the herd is 4.32% fat and 3.29% protein.

The heifers are averaging 21.7L so are on target to meet the current herd average of 26.2L when they reach maturity in their fourth lactation. Now the herd is in a single block, more selective breeding can be undertaken, this hasn't been an option currently as the creation of the block required every cow to be mated with a dairy straw and calves kept ensuring enough replacements were obtained at the front of the block. This selection pressure will see more heifers entering the herd with fat and protein percentages around the 5.8% and 3.8% instead of the 3.3% and 2.7%.

The Holstein Jersey cross calves were born around 15 kg lighter than previous generations out of the Holsteins which is promising for decreasing the average liveweight of the herd. With the litres from the mother, the fat and protein percentages from the father and with 100% hybrid vigour the potential efficiency of these heifers is huge and in 2023/24 we will be able to see how they stack up against their mothers and pairs within the herd.

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