Producing beef from the dairy herd: understanding system complexity and its implications for calf health and welfare

A study carried out in the UK, US, Canada & the Netherlands

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Summary

Currently ~50% of all beef produced in the UK comes from the dairy herd (AHDB, 2017). This in part is due to the successful collaboration of industry and the 'Beyond calf exports forum' which resulted in an increase in dairy bull calves being incorporated into UK beef supply chains, a reduction of calves killed on UK dairy farms and a ban on live exports of calves. There is huge potential in utilising calves born to dairy dams as a sustainable and viable option for protein production in order to feed a growing population which is expected to increase to 10 billion by 2050 (World Bank, 2019) however, despite movements to improve supply chain integration, complexities remain which put calf health and welfare at risk.

Disease, which ultimately effects welfare within the dairy beef supply chain is a concern especially given the requirement to reduce antibiotics (MSD Animal Health, 2017) as well as ensuring sustainable, economically viable production.

This report set out to investigate different calf rearing (for beef) systems in the US, Canada, the Netherlands, and the UK and how the system complexities in each of these countries impact on calf health and welfare. A total of 11 farms (14 units) including veal, dairy-beef, cow- calf and feedlot systems were visited with the intention of viewing the calf rearing environment in different countries as well as discussing the system challenges and opportunities with the primary calf rearer. In addition, the researcher visited the National Cattle Beef Association Convention in San Antonio, Texas to attend a range of talks and demonstrations and to talk with calf rearers. This report presents, case study summaries of the key challenges and opportunities of each farm visited, a reflective summary of the findings from each of the countries and the key impacts and outputs for agricultural educators. Complexities within the calf rearing systems lead to a range of health and welfare issues, different countries aim to combat these challenges with legislative and system processes, however it is evident that stress in calves can result in disease such as bovine respiratory disease and scour being problematic (and resulting in high antibiotic use). The benefit of this study from an agricultural educator perspective is the understanding of these complexities which can be communicated to students in order to understand new and innovative ways to resolve the key challenges for the UK calf rearing sector in the future.

Report Foreword

The topic of calf welfare is emotive. The UK media and activist groups have played a part in driving the consumer zeitgeist, which paints the dairy industry in a poor welfare light. In 2017 the Guardian's article '*Dairy is scary. The public are waking up to the darkest part of farming*' emerged, persuading consumers to move towards a plant-based milk solution. Figure 1 shows an image used in the article of calves at a farm in Dorset. The article explains to readers that if a calf is male '*he will probably either be shot and tossed into a bin, or sold to be raised for veal, which delays his death by just a matter of months*.'

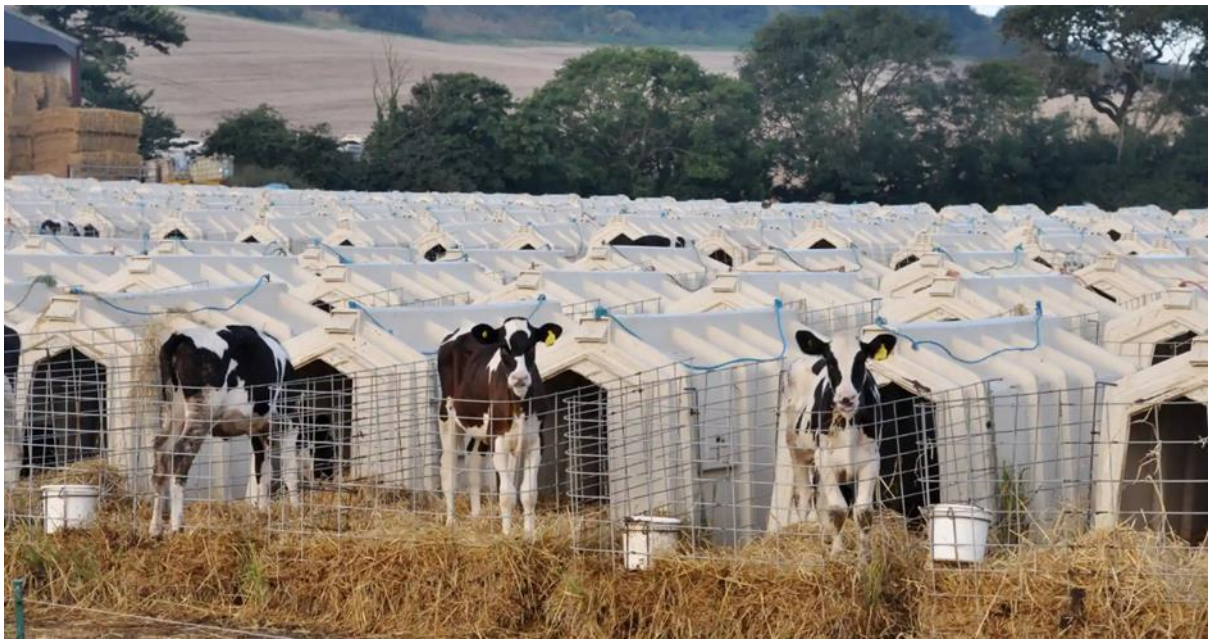


Figure 1: Picture of calves at a farm in Dorset, published in the Guardian 2017

Many in the agricultural sector will disagree with this article and the statements made within it, however there is no disputing the loudness of the voice or the presentation of the message to consumers on its national stage with 23 million readers (34.9% of the UK population in 2017) (Guardian, 2018). Movements such as 'Project calf' have also caused issues for the dairy industry with activists provided with the details of dairy farms and encouraged to use footpaths to obtain footage (Farmers Guardian, 2019). The emotive nature of calf welfare is not just a UK problem either and throughout the investigations carried out for this report, farmers or producers often expressed concern with their name and farm location being associated with a calf 'health and welfare' report. With this in mind and in order to comply with GDPR practice farms are coded and any identifying material removed from pictures throughout the report.

Introduction

Approximately half of the beef produced in the UK originates from the dairy herd (AHDB, 2017). Dairy beef production is a sector with significant challenges but with significant opportunities. The societal and production challenges include high levels of morbidity and antibiotic use within calf rearing (due to moving young calves, stress lowering immunity and mixing) and the unnecessary culling of male dairy calves (due to TB challenges and lack of facilities). Key issues include high rates of bovine respiratory disease (BRD) and scour. BRD is one of the most prevalent diseases affecting pre-weaned calves (Cramer and Stanton, 2015) with mortality rates in dairy calves ranging between 3.1% and 9.4% across countries (Johnston et al., 2016) and subclinical prevalence ranging from 23 – 67% (Cramer and Ollivett, 2019). Scour or diarrhoea is an enteric disease affecting calves globally and typically impacts calves in the first 28 days of life (Lowe et al, 2019). Mortality and morbidity from both of these diseases are important from both economic and welfare standpoints (Hixon et al., 2018) with a lack of performance reducing farmer income as well as the feeling of malaise which accompanies disease compromising animal welfare (Cramer and Stanton, 2015). BRD and scour are often treated with an antibiotic following clinical observation of signs. Due to the increased need to safeguard antibiotic use as a result of antibiotic resistance (O'Neil, 2015) unnecessary treatment with antibiotics needs to be avoided. However, animal welfare is also of importance and animal carers should not allow suffering as a result of disease to occur. Addressing these health and welfare issues that arise from complex system challenges requires an understanding of the system, reflection on the challenges and innovative ways of thinking.

The UK dairy beef sector offers the potential to deliver a high-quality protein source to a growing population both nationally and internationally. The sector has been growing steadily, following the work of retailers, NGO's and industry stakeholders which worked to ban live exports of calves in 2008 and agreed commitments to develop markets for dairy beef calves. Despite this success, the dairy beef industry still falls behind the pig and poultry sectors in terms of production efficiencies. There is still a high proportion of male dairy calves that are underutilised in the supply chain as a result of lack of facilities, economics and TB, ultimately, we can do better in terms of improving the health and welfare of these calves.

Unlike the pig and poultry sectors, there is relatively little information and research into the UK dairy beef sector, with the majority of research focused on the dairy heifer replacement industry specifically. Whilst this study does not provide a comprehensive understanding of what is required, it is hoped that by using the system in the education setting, interest and innovation may result in the form of student projects/ dissertations and work placements.

Visit Details

This study involved travel in 4 different countries, the UK, US, Canada and Netherlands and incorporated 11 farms/ businesses over 14 units. Originally, the author intended on looking only at young calf rearer > 5 months, however following discussions throughout the journey it became evident that the stressful situation of transit was often a catalyst for health and welfare challenge and therefore cow-calf systems which fed into feedlots were also observed.

The details of the 11 farm business are shown in Table 1 below:

Table 1: Farm codes and details of farm businesses visited during study

Farm Code	Type	Location	Size*	Age @ entry	Weaned @ entry	Market
A	Veal	Ontario, CA	850	< 1 week	N	Integrator
B	Veal	Ontario, CA	200	< 1 week	N	Auction
C	Veal	Quebec, CA	700	< 1 week	N	Dealer/ Auction
D	Cow-calf	Quebec, CA	130 + 80	Birth	N	N/A
E	Veal	Utrect, NL	450 + 300	4 weeks	N	Integrator
F	Veal	Gelderland, NL	140	4 - 5 weeks	N	Integrator
G	Veal	Utrect, NL	250 + 250	4 - 5 weeks	N	Integrator
H	Dairy-beef	Somerset, UK	350	3 – 4 weeks	N	Direct
I	Dairy-beef	Hereford, UK	100	3 – 5 weeks	N	Integrator
J	Feedlot	Texas, US	7600	6 months	Y	Auction
K	Feedlot	Texas, US	3500	6- 8 months	Y	Auction

**At full capacity*

Questions asked

Despite each visit posing different questions in order to understand the system and its complexities, the author asked 2 key broad, open ended questions of qualitative nature to each farmer/ producer in order to build consistent farm case studies. The 2 questions are detailed below:

1. What are the key challenges that you face in terms of health and welfare?
2. Are there opportunities to improve this?

Farm Case Studies: Challenges & Opportunities

Case Study Summary: Farm A

Key challenges

Calves come from an integrator who picks up calves in lorry and transports them, there is no law around time in transit but think this will come soon (as in UK). Don't know anything about the calf when it arrives, no history of medicines or if it has had problems. Treat everything with antibiotics because it would be too risky not to. Biggest issues are respiratory disease and scour, often within the first 3 weeks. Problem is that dairy farmers don't really care, even though they get paid well.

Opportunities

Restriction on time in transit may help calves to be less stressed but could also be a barrier to calves being utilised for meat supply chain – may result in increase in euthanasia. Would like to get calves earlier so that can impact health from younger age, at the moment they are wasting time at the dairy when they could be cared for better here. Try to minimise contact as much as possible to reduce disease and get straight on to good nutrition to sort out nutritional scour. Electrolytes on arrival help with transport dehydration.

Case Study Summary: Farm B

Key challenges

Family change has resulted in contraction of veal unit, cant afford to employ another person so have just cut production. There is also worry about the movement laws that are due to come in which will mean calves have to be over 8 days before they are transported, and they will not be able to travel more than 12 hours (currently 18). Dairy farmers will ruin the calves as they don't have the time or resources to feed them, we are a huge country its not like transport in the EU countries. Biggest disease problem is probably respiratory because of the impacts from both stress and weather changes.

Opportunities

At the moment we get calves in early and control them almost from birth. We can help them out with their immune system, give them the right food and have much better care. Everything is given antibiotics to prevent infection and we try to control the environment as best possible (with automatic gale breakers) to prevent draughts getting in.

Case Study Summary: Farm C

Key challenges

Cost of feed and disease. There are high input costs plus the need to treat all animals for common disease because they don't have fully developed immune systems.

Opportunities

Better care of calves from dairy farmers, especially if new laws on transit come in. Would like to feed higher quality milk powder but economic margins don't allow it.

Case Study Summary: Farm D

Key challenges

Biggest problem with calves is noticing them before they have a big issue! Generally, have very few problems because calves are on the cows and get quality colostrum and care from their dam from birth. If a calf has pneumonia or another disease we probably only know when it is too late, but it happens very rarely. Weather can be a problem. Would like to expand business but finding good stock people is increasingly difficult (site split so need someone trustworthy). People are moving away from agriculture or fewer people are coming into the practical side of it. We need good stock people that have an eye for health and welfare, your herd health is only as good as the people that work for you.

Opportunities

In terms of health and welfare, not really any more opportunities. The system works really well. There is an opportunity for the sector to make agriculture attractive and to ensure that we train the next generation well.

Case Study Summary: Farm E

Key challenges

Health and welfare will always be a challenge because we are taking a by-product of another industry. You really want to be able to have control from the beginning but that's not how the industry works. Biggest issue on our unit is scour, then probably respiratory disease.

Opportunities

Working with an integrator and ensuring good nutrition. We invest in our feeding because it is an investment in health, lots of farmers try to cut back food but higher quantities result in a more robust animal, you cant cut corners in this business. You can do smoke tests to make sure you have your ventilation right, that really helps reduce disease.

Case Study Summary: Farm F

Key challenges

High welfare unit (environmental enrichment provided) but still have issues with cross sucking, have tried different nutritional regimes but no change. Transport stress means that the immune system is put at risk at an already vulnerable time.

Opportunities

Barn is designed for purpose, heated slats in cold and air conditioned when hot. Complete environmental control helps to reduce disease and therefore improve welfare. Manage transition as best as possible through working with integrator who ensures nutrition is the same at dairy, also give electrolytes to new calves when they arrive. Reduce stress, good nutrition and good environment are corner stones for success.

Case Study Summary: Farm G

Key challenges

Respiratory disease is a big problem, managed to stop using antibiotics on entry but still lots of treatments required. Building is built specifically for calves and work closely with integrator who helps with sourcing good calves but despite this respiratory disease and scours are a problem. Lack of land availability means we have to farm in sheds, ammonia is possibly contributing to respiratory problems.

Opportunities

Alignment with integrator and nutritional plan. Buy feed from a large company that invests in research and development as well as supporting through problems. Unit is high welfare which means there is a premium paid for the product, we provide environmental enrichment to the calves and the higher payments mean that we can make money!

Case Study Summary: Farm H

Key challenges

Ensuring that animals fit the specifications required by the processors/ retailers. Working with dairy farmers to help them understand this as the breeding choices ultimately sit with them. Requirement for integration throughout the chain but it is still very disjointed.

Opportunities

Better integration! Start from the dairy, ensure good colostrum and nutrition is provided and manage this as a buyer. Vaccinate calves at the dairy prior to movement to help reduce respiratory disease post transition (and also avoid vaccinating at a stressed time = low immunocompetence). Invest in quality calf rearers who are specialists. Environment is important too but essentially lay the groundwork and you will have a healthier calf from the beginning. Know your market so that you know that you have income!

Case Study Summary: Farm I

Key challenges

Disease levels following transition stress. Calves coming from multiple sources, mixing and sharing disease pathogens plus the stress of movement results in high amounts of disease during the first few weeks. Don't give antibiotics to everything on entry but do feel like firefighting disease with individual treatments needed. Weather can have impact on health too so need to invest in good housing to provide suitable environment for calves.

Opportunities

Work with integrator to feedback poor calves so that they can report back to dairy farmer. Often if dairy farmer provides bad calves consistently the integrator will stop doing business with them, protecting the rearer. Give calves electrolytes following transport and allow to rest fully before trying to handle otherwise it causes more unnecessary stress. Keep environment clean and hygienic to reduce disease transmission and isolate anything with disease symptoms.

Case Study Summary: Farm J

Key challenges

Variety of backgrounds, movement of animals and mixing results in a bloom of disease once they arrive. Trusting riders to pick out sick animals before they become more of a problem. Finding staff that are dedicated to the job can be a challenge.

Opportunities

New technologies and ensuring good riders are dedicated to the job. Supporting your business with the right personnel and equipment saves money in the long term. Identification of disease early stops spread and reduced cost of medical inputs.

Case Study Summary: Farm K

Key challenges

Despite being a smaller system to most, disease problems are still an issue. Try to minimise mixing as much as possible but it still exists as calves need to be grouped based on size otherwise the older ones bully them off feed – mixing results in disease spread as all farms bring their own pathogens.

Opportunities

Buy slightly older, possibly more resistant animals from as fewer sources as possible to reduce mixing. Make sure you have a good relationship with your vet and a good health plan as well as investing in staff training days so that they know the protocols and symptoms of disease as well as understanding the nutritional requirements.

Reflective overview of the systems within countries

United Kingdom

The author visited 2 specialist dairy-beef calf rearing units in the UK. Over 50% of UK beef comes from this system which relies on calves from the dairy industry which would otherwise not use them based on dairy replacements rates being at 25%. Calves within the dairy-beef system are either purebred dairy males, which are predominantly used in the Rose Veal supply chain or cross bred beef calves, using predominantly Angus, Hereford, and British/ Belgium Blue genetics. These calves sell for higher prices and can enter a variety of markets. Increasingly there is pressure and incentive for dairy farmers to invest in sexed semen for their heifer replacements and breed non-replacements to a beef sire. Calves are born at the dairy and not moved before they are 14 days old, meaning that the dairy farmer has full responsibility for ensuring that the calf receives adequate colostrum, sufficient nutrition, and a comfortable, clean environment prior to movement. Although some dairy farms do fatten their own calves for beef, more commonly calves are sold at markets, through integrators or directly to calf

rearers. This requires the movement of calves from one farm to another, often with a drop off between (e.g. at a market) and sometimes long journeys.

The first dairy-beef unit visited worked directly with dairy farmers to source calves, ensuring that they could impact the attitude towards the calves. Nutrition was managed in the same way, meaning that no additional stress was placed on the animal when it was moved and vaccination (to respiratory pathogens) was undertaken at the dairy farm enabling the vaccine to be administered at a time when the calves immune system was not under stressed. Calves were reared in a large barn with air sock fitted to provide ventilation. The second farm, on the other hand worked with an integrator who picked up calves from different dairy farms where nutrition was different, and no vaccination was given prior to transit. Housing was a specialist igloo design for calves combined with fresh large bedded yards. Animals were mixed from different farms as well as from a mixture of age groups. Neither farm gave antibiotics on entry, but the second farm stated that antibiotic injections in response to respiratory disease were common.

Key reflections:

- The benefits of working directly with dairy farmers to encourage trusted relationships and the reduction of transition stress for calves
- Vaccinating calves prior to movement – otherwise calves are vaccinated during the first week of arrival to a new unit when their immune system is under stress (and therefore vaccination may not be successful)
- Ensuring nutrition is maintained – changing feed can add an additional stress to calves and increase disease susceptibility
- Investment in specialist housing – UK systems often make best use of existing barns; Igloos present a useful solution for calves and are practical
- Movable housing is a good option for young farmers who don't own their own land and/ or have planning to build barns

Figure 2: Igloo housing design

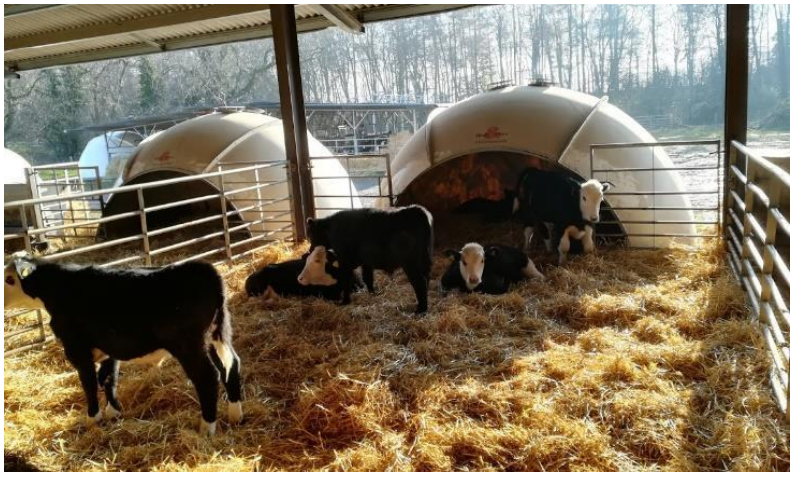
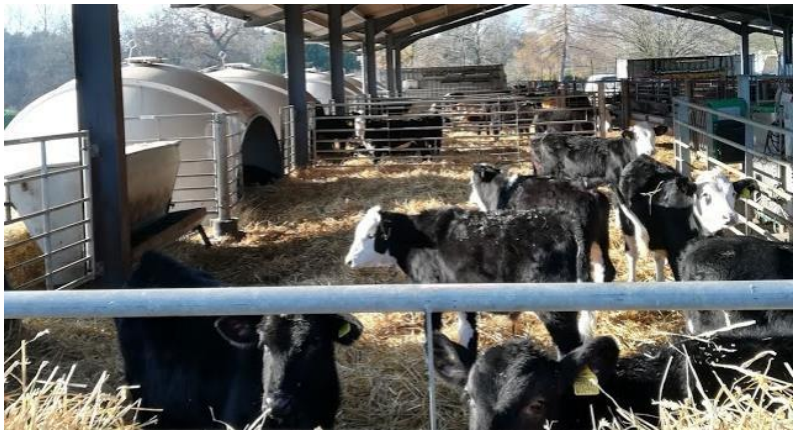


Figure 3: Igloo design with open straw yard design



The Netherlands

The Netherlands system, due to EU legislation is not significantly different to the UK system reflected upon above. The system does however seem to run in a more functional integrated capacity. There is a higher focus on nutrition and reducing transitional nutritional stress, the calf rearing environment and investment in specialist housing design is a key significant difference to the UK. Transition stress, from the dairy to the veal/ beef rearing facility and the mixing of calves from different farms remains a challenge for respiratory disease and scour however none of the farms visited were using antibiotics prophylactically. Optimum nutrition and investment in good nutritional plan were seen as a method (all farms visited) to combat health issues by supporting the immune system. All farms received calves through an integrator who also managed the health protocol and nutritional plan. All farms visited reared black and white/ purebred calves; this is because this carcass type is well integrated into the meat supply chain already. One farm was a white veal producer, meaning that the calves only received milk and no cereal/ concentrate to supply a specialist meat market. One of the farms received a premium for its veal by employing a 'high welfare status', this required the provision of enrichment

which is shown in Figures 4 + 5. Included were balls at calf height to stimulate play and blank teats on the wall to reduce cross sucking between calves. All buildings were specifically designed for calves, a key difference to the UK systems which utilised existing farm buildings. Buildings all had slatted floors, using a specialist material that meant excrement fell between the gaps into a collection pit. The slats were connected to a solar PV system which meant that they could be pumped with hot water in the winter to ensure a constant ambient temperature for calves, in the summer the sheds would be cooled with air conditioning. The building height was approximately 15 ft, much lower that UK barns as calves do not produce a stack effect and therefore empty space at the top of the building would result in stale air and an increase in space for aerosol pathogens. Building design is perhaps more specialist due to the lack of land availability in the Netherlands. Dairy cattle occupy a significant proportion of grazable land, therefore pig, poultry and veal systems are designed to be single housed units running at high efficiency.

Key reflections:

- Integrated systems help to provide consistency in health protocols and a bridge for nutrition reducing transition nutritional stress
- Specialist housing design assists with managing temperature (a key contributor to BRD in UK systems)
- Slatted floors result in reduced input costs in form of bedding, reduce disease reservoir (compared to straw bedding) and reduce labour requirement (time bedding up) however from a consumer perspective they do not look as good, although can be supplemented by enrichment such as balls and teats
- Antibiotics can be reduced by helping the body function through good nutritional provision, investment in nutrition = reduced cost in disease interventions

Figure 4: High welfare unit, note slatted floors and enrichment ball

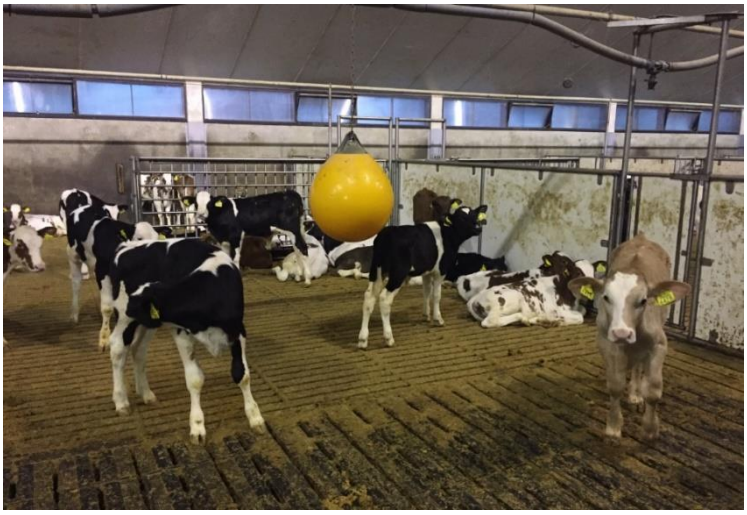
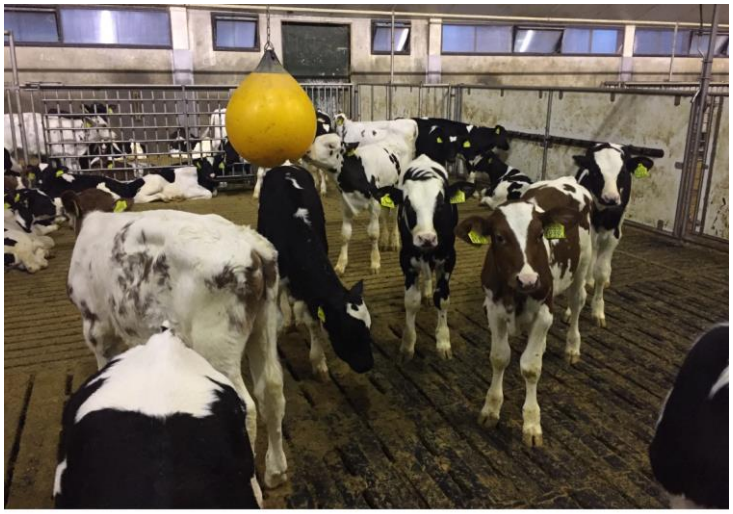


Figure 5: High welfare unit, note enrichment ball and black strip on wall which has blank teats attached



Canada

The veal industry in Canada was particularly guarded, the author had to work hard to gain access to these units which the farmers stated was due to a societal pressure and negative judgements made of the industry. Whilst the author feels that the farmers opened up once they arrived and were able to sympathise with the system based on their own positionality, it is acknowledged here that the full complexity of the system was difficult to understand due to the understandably guarded nature. At the time of visit (October 2019) the veal industry was subject to a legislative change process, this therefore played a significant role in discussions. At the time of the visit calves could be transported off the dairy a few days after birth, since the visit this has changed to a calf having to be 8 days old before transport to a sale barn or assembly centre. The only exception to this rule is where calves are loaded individually in trailers that do not have internal ramps, have enough space to lie down, are separated from animals over 8 days and stops can only be made to pick up additional animals. Animals in transit should have 8 consecutive hours of rest following 12 hours of transit before moving again. Whilst this legislation is more consistent with EU policy, and therefore may not be perceived as a fundamental change to UK readers due to the geographical vastness of Canada and the culture of dairy farmers who often perceive calves as waste and do nothing with them until they are picked up for the meat industry it is a significant change in practice. During the authors visit, veal producers were concerned about the 8-day rule which would apply to their calves due to them being put through sale barns and assembly centres. The perception was that the sooner a calf could arrive on the veal unit, the sooner it could be looked after properly from nutritional provision to ensuring a sufficient immune system using therapeutic measures. Calves arriving at the veal units were taken on as early as possible, in most cases less than 1 week of age which was the preference of each of the units visited.

Calves came from a variety of sources assembly centres (integrator), sale barn (auction) and a combination of the two. This meant that calves were put under transport stress, often traveling long distances of over 8 hours due to the distance between dairy farms and centres in Canada as well as mixed with calves from different sources often with little colostrum (stated by the veal producers) provision meaning that most calves would have little to no immune response. Additionally, calves would arrive without any disease history or record of colostrum provision. The complexity of this system means that antibiotics were provided prophylactically to all calves upon entry to each of the units visited, the producers stated that without this blanket treatment the welfare of calves would have been further compromised and therefore it was necessary to provide this. An additional complexity exists in the input costs for the systems, this was reflected upon by each of the producers who stated that they could not afford to invest in more expensive nutrition as it would make the business unviable. The housing was more specialised that UK systems but less efficient and purpose built than the Dutch units, due to the cold winters, automatic temperature-controlled gale breaks were installed in 2 of the 3 units (1 was manual). Straw bedding was provided in all of the units.

In addition to the veal units visited, a single cow-calf system was visited to offer an in-country comparison. The system provided a stark contrast. Calves were kept on the dam up to weaning at 5 months of age, BRD and scour were very rarely seen and antibiotic treatments minimal. The cow-calf system manager stated that he had not seen a case of BRD in 8 years. BRD is mainly associated with weather change, especially extremes (cold night, followed by humid day). At 6 months, calves were transported off the system to be fattened on a feedlot system. The biggest challenge to the system was labour and finding someone that was trustworthy and committed to health and welfare. There was the perception that agriculture isn't attractive to graduates and/ or the intensity of work and working hours make it difficult to find dedicated staff. The producer stated that there is a gap for training in this sector.

Key reflections:

- Legislative change will result in a significant change in the system, which is likely to require a culture shift and new ways of working
- Key health challenges exist in transition stress (movement and nutrition) and mixing of calves
- Antibiotics are required prophylactically to support the system
- Housing design is more specific than the UK but not as sophisticated as Dutch systems
- Integration in the context of this system means that calf dealers work to provide batches of calves to go on to units, however there is a way to go to full integration as health history, colostrum status and nutrition are not followed from the dairy to veal units

- Cow-calf systems offer a stark contrast to the health and welfare of calves with BRD and scour representing very low incidence
- There are opportunities to improve and promote the training of stock people for the industry to grow

Figure 6: Veal unit with ventilation sock to provide air circulation

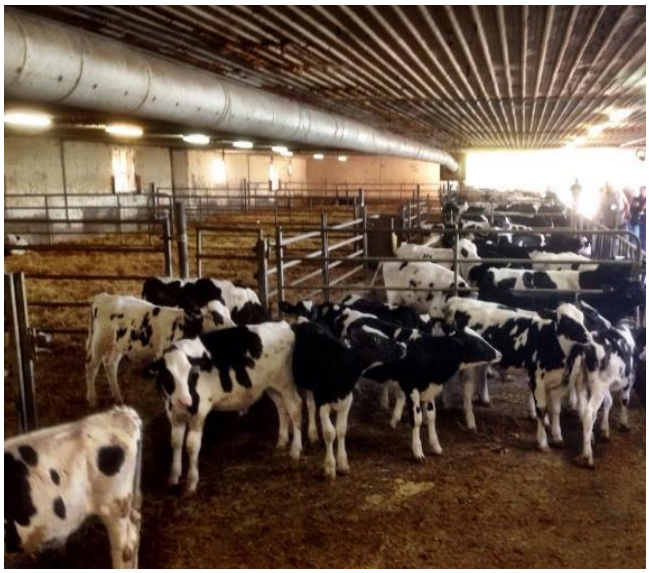


Figure 7: Loose bedded calves in a veal barn, note automatic gale breaks which were closed to provide shade in high heat

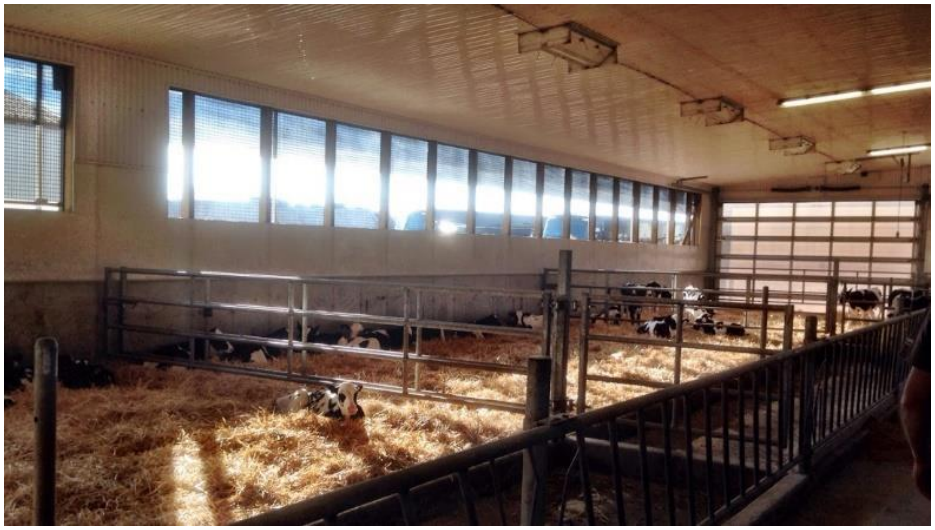
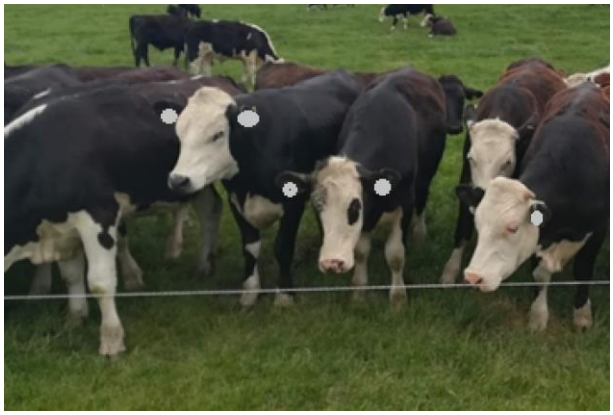


Figure 8: Weaned calves on the cow-calf system



United States

2 feedlot systems were visited in the US to help understand how the challenges of transport and mixing can manifest at different stages along the system. The cow-calf system in Canada showed that calves was a stark contrast the veal systems which exhibited challenges due to movement and mixing stress at a young age. The author wanted to visit feedlots to understand if despite calves being kept on the dam for longer and therefore having better colostrum management and nutritional provision, whether the impacts of movement and mixing would result in disease challenges. The author visited the San Antonio, NCBA to speak with a range of vets and producers and attend talks as well as visiting 2 feedlots. Despite calves being reared on cow-calf systems, it appears that due to long journeys often in heat extremes, coupled with mixing with other calves and a nutritional change BRD is still a common challenge upon arrival at a feedlot as well as during times of extreme weather. The feedlot systems visited did not use prophylactic treatment of antibiotics upon entry, but animals required regular intervention and targeted antibiotic treatments based on clinical signs seen by pen riders. Again, the training of pen riders was stated as an area that could be enhanced in order to improve the health and welfare of calves.

Key reflections:

- Key health challenges exist in transition stress (movement and nutrition) and mixing – long distances covered = dehydration and stress resulting in immune compromise
- Antibiotics weren't provided prophylactically in the systems visited but the producers stated many others do provide antibiotics in this manor
- Targeted treatments and good pen riders are required to stay on top of disease

- Calves kept in outdoor yards – this means that they are exposed to a range of weather conditions (extreme heat and cold)
- Weather conditions contribute signifcactly to BRD
- Training and dedicated pen riders are critical to system success

Figure 9: Feedlot yard Texas, cattle in groups of 80 – feed bunk provided at front of yard

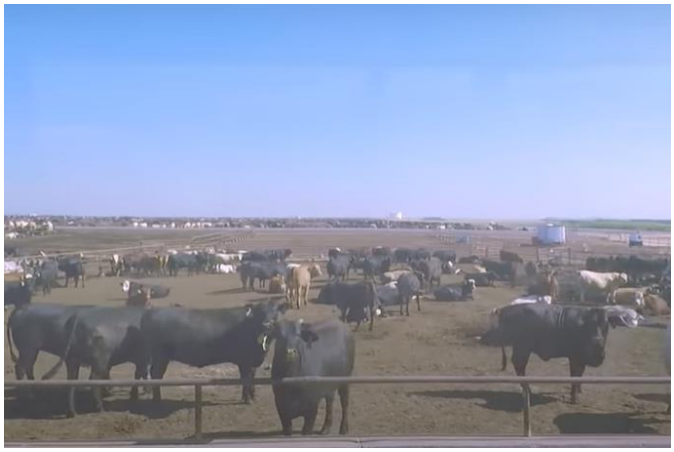
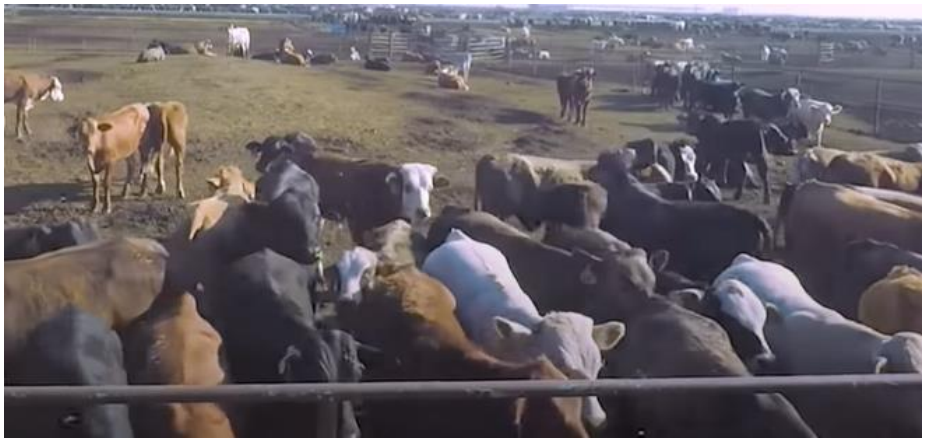


Figure 10: Feedlot yard in Texas, note the variety of calves in a single yard both size and breed



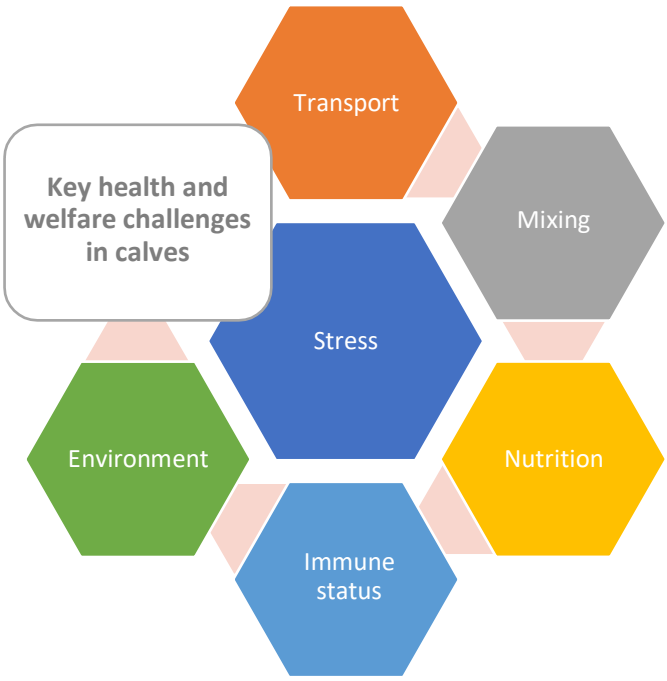
Summary

Key impacts & outputs for agricultural educators

The key impacts on calf health and welfare that were exhibited across systems are represented in Figure 11. A brief explanation is also provided below:

- **Transport**: time spent in transport contributes to increased stress as well as dehydration and lethargy
- **Mixing**: of calves is a challenge due to the exposure to new diseases/ pathogens as well as new calves which may bully smaller ones
- **Nutrition**: the stress of changing diet can play a significant role in reducing the effectiveness of the immune system, it can also result in nutritional scour leading to dehydration
- **Immune status**: where colostrum is not provided, the calf does not have a robust immune system to cope with the other factors
- **Environment**: plays an important role in calf health, specialist buildings help reduce the harmful impacts of extreme weather change
- **Stress**: is a factor associated with all of the impacts above, stress contributed significantly to immunocompetence and is an important factor for both health and welfare

Figure 11: Key health and welfare challenges identified in calves from travel study



System complexity

The variety of systems visited show that there are many ways in which calves are reared which result in health and welfare challenges as well as opportunities. Agricultural educators are encouraged to reflect on system complexities such as legislation, input costs and the culture of the dairy and beef

industries in order to communicate why the problems identified in Figure 11 arise. It is acknowledged that in the context of this system it is very difficult to solve problems individually. For example, trying to improve health and welfare by reducing BRD is not simply a case of treating the disease in isolation or finding a novel technology to diagnose it, it is about understanding why the disease occurs in the system and then finding novel methods to combat the challenge. This study does not pretend to know the answers; however, some innovative ideas are summarised below for the purpose of agricultural educator outputs:

- Integration between the dairy and veal/ beef industries – encourage follow through nutrition and vaccination at the dairy
- Health records – provide a bridge between the industries and record colostrum, disease history
- Reduce mixing of calves – where possible reduce mixing to prevent disease and maintain established relationships between calves
- Provide a specialist calf environment – ensure sufficient ventilation and reduce/ control temperature extremes throughout the day
- Provide enrichment – where environment does not provide it, both from a consumer perspective as well as to avoid cross sucking and boredom in calves

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