Is A 50,000 litre Lifetime Production Herd Average A Reality?

A Study Of Factors That May Enhance The Lifetime Performance Of Dairy Cows

By

Dr Aidan Cushnahan

College of Agriculture, Food and Rural Enterprise

Greenmount Campus

Report for the Farmers Club Charitable Trust Agricultural Educator Award 2017

Acknowedgements

This study tour would not have been possible without the generous Agricultural Educator Award provided by the Farmers Club Charitable Trust. Financial assistance from the Department of Agriculture, Environment and Rural Affairs (DAERA) is also appreciated. I would also like to thank Dr Frank Buckley, Teagasc, Dr Stephen LeBlanc, University of Guelph, Dr Bradley Heins, University of Minnesota, Dr Mike Van Amburgh, Cornell University, Mr James Thompson, Gold Dust Dairies and Ms Roselinde Goselink, Wageningen University Research for all their help with the organisation of my study tour. Thanks are also due to Mr Ian McCluggage, DAERA and Mr James Cross, Farmers Club Charitable Trust, for their support and encouragement as well as Mr Trevor Alcorn, DAERA, Dr Alastair Macrae, University of Edinburgh and Dr Mark Little, Trouw Nutreco for their observations and assistance. Last and by no means least I would like to thank my wife, Aisling and wider family circle for all their help and support provided during the study tour

Contents

Abstract

Improving the lifetime performance of dairy herds in the United Kingdom may present major benefits to the dairy industry in terms of improved farm profitability, a reduced environmental impact and enhanced welfare and marketing opportunities. The following report, sponsored by the Farmers Club Charitable Trust, has examined the impact of transition cow management, heifer rearing and breeding technologies (cross breeding) on the lifetime performance of dairy cows with a view to determining whether it is possible to achieve an average herd performance in the United Kingdom of 50,000 l milk/ cow.

A study tour was taken of sites in Canada, The United States of America, The Netherlands and the Republic of Ireland to review the work carried out in these areas and assess the implications of adopting these technologies in the United Kingdom. Results from the tour showed that reducing the incidence of sub clinical ketosis in transition cows, rearing calves on an accelerated growth programme (approaching 1.0 kg/ calf/ day) between birth and weaning, achieving an average age at first calving for heifer replacements of 24 months and the use of specific cross breeding programmes (Holstein x Montbeliarde x Viking Red) all had a positive impact on the lifetime performance of dairy cows. Other breeding technologies, in particular the use of genomics, can also improve cow longevity. Dairy herd managers should set up monitoring programmes for detecting ketosis and sub clinical ketosis in their herds and implement management programmes to reduce the incidences of transition cow disorders in their herds as well assessing the potential of their replacement heifer rearing systems to achieve growth rates approaching 1.0 kg/ calf/ day in the pre weaning period and an age at first calving of 24 months. While use of the cross breeding programme highlighted major potential benefits for improving lifetime performance, further work needs to be carried out to assess the impact of this crossing pattern on herds managed under a moderate concentrate input/ high forage based feeding regime, similar to that used by many dairy herds in the United Kingdom. It is also concluded that there is a need to carry out a programme of research aimed at developing a predictive model which will assess the impact of adopting best management practices on the lifetime performance of dairy cows

In conclusion the improvements already experienced in dairy herd fertility and mastitis management with dairy herds in the United Kingdom, combined with improvements in transition cow management, calf rearing and use of new breeding technologies could help the dairy industry in the United Kingdom to achieve an average herd lifetime performance of 50,000 l milk/ cow. The information gained from this study tour has already been disseminated through the delivery of Business Development Groups and will be incorporated into the learning materials of other educational programmes at the College of Agriculture, Food and Rural Enterprise.

1.1 Introduction

During the last four decades, milk production per cow has increased dramatically both in the United Kingdom (UK) and across the world. However this change has also been associated with increased incidences of diseases and reproductive failure, which in turn has resulted in increased culling rates among many UK dairy herds. For some herds this has resulted in significant financial implications. For example, analysis of UK heifer rearing costs has indicated that while the average payback period associated with the costs of rearing heifer replacements is around 530 days, in some cases this could be as high as 2,000 days (Boulton, 2015). Given that the average productive lifespan of a dairy cow in a UK dairy herd is around 3.6 lactations, this would suggest that there are limited opportunities to gain an extended financial return for many dairy livestock.

One potential solution available to address this issue is to develop management programmes that will improve the lifetime performance of the dairy herd. Achieving this outcome would have a number of potential benefits. They include:

1) Improved dairy herd profitability through reductions in replacement rate
2) Reductions in environmental pressures associated with dairy units through improvements in nitrogen and phosphorus use efficiency and reductions in greenhouse gas (GHG) production
3) Improvements in the public perception of the dairy industry in terms of improved animal welfare through better health status, reduced antibiotic use and longer lifespans with dairy cows. Indeed this is likely to be one of the major challenges faced by the dairy industry over the next 10 years

While individual cows with a herd may on occasion produce 100,000 l milk in their lifetime, analysis of herd performance data shows that average herd performance is significantly less than this. For example, analysis of milk recording data by Hanks and Kossaibati (2017) would indicate that the average lifetime performance of UK dairy herds is around 27,000 l/ cow. Achieving an average lifetime herd performance of 50,000 l/ cow would appear at first glance quite challenging. Nevertheless advancements in animal husbandry have already raised lifetime performance over the years. In addition work carried out by Scheffer (2017) has shown that the management of the dairy cow, as with any biological system, exhibits a certain degree of biological resilience but that tipping points exist which if exceeded can either enhance or reduce the efficacy of that system. Therefore it may be possible to achieve this target by identifying tipping points or avenues which have not received greater attention until recently and by incorporating them into existing management programmes. For example, stress created by metabolic, immunological and social based factors have recently been identified as having an impact on the lifetime performance of dairy cows. While some of the effects arising from metabolic factors such as oxidative stress and inflammation are not completely understood and are still being investigated, other factors have been identified to have an impact on dairy cow performance and it is some of these factors that I propose to investigate in more detail. They include:

1) The strategy adopted with cows during the transition period through calving and early lactation
2) The strategy adopted when rearing heifer calves and replacements
3) The role of cross breeding in affecting cow performance

In order to investigate these factors thoroughly I decided to organise a study tour of sites in North America, the Netherlands and the Republic of Ireland, the funding for which was kindly provided through an Agricultural Educator Award provided by the Farmers Club Charitable Trust. The reason I decided upon these destinations was so that I could discuss aspects of improving lifetime performance of dairy cows with individuals who are actively involved in research into transition cow management, calf rearing and cross breeding and are respected as leading experts in their fields of study. The people I arranged to meet to discuss these subjects included:

1) Dr Stephen LeBlanc and Dr Trevor DeVries (University of Guelph) – transition cow management
2) Professor Mike Van Amburgh (University of Cornell) – heifer rearing
3) Dr Frank Buckley (Teagasc, Moorepark) – cross breeding
4) Dr Bradley Heins (University of Minnesota) – cross breeding

While I was at these sites I also had had the opportunity to review some other factors that may affect lifetime performance which included the use of genomics. In addition I visited dairy units in Ireland, Canada and the United States plus I attended a conference on transition cow management at Wageningen University Research (Wageningen UR), the Netherlands. I also visited the Royal School of Veterinary Studies at the University of Edinburgh and arranged to meet Dr Mark Little, Trouw Nutreco, to gain further information on the factors affecting lifetime performance of dairy cows. The following report will describe my findings into how these various factors affected lifetime performance and will discuss the potential implications for adopting them within the management of UK dairy herds with a view to achieving a herd average of 50,000 l/ cow. The information gathered in this report will be disseminated through Business Development Groups, where farmers in these groups develop their skill base through discussing relevant technical issues and sharing information and through developing learning materials for other formal education programmes at the College of Agriculture, Food and Rural Enterprise (CAFRE).

2.1 What is meant by lifetime performance of dairy cows?

The longevity, lifetime performance or lifespan of a dairy cow is often described as the time from its birth until the animal leaves the herd. Lifetime yield is in turn expressed as the total milk yield achieved during this period or the average daily yield achieved throughout the cow's lifetime. The time at which the animal leaves the herd may occur because of its death or a decision has been taken by the herd manager to remove the animal from the herd.

Analysis of National Milk Recording (NMR) data across 500 herds by Hanks and Kossaibati (2017) would indicate that the average lifetime performance of UK dairy herds is around 27,000 l/ cow (Table 1). A review of milk production data in Northern Ireland by CAFRE has shown similar trends with an average lifetime performance of around 27,600 l/ cow (Mackey, personal communication). Indeed if we look at the top performing herds for lifetime performance in the UK such as the CAFRE dairy herd (Future Herd) which recently achieved a lifetime performance target of 40,000 l/ cow, it would appear that reaching a herd average of 50,000 l/ cow remains a challenging target.

Nevertheless further work by Hanks and Kossaibati (2017) has shown that significant increases in lifetime performance have already been achieved in recent years and that given what has already been achieved among the top 25 % of herds suggests that further increases are possible (Table 1). However it would appear that for the target of 50,000 l milk/ cow to be reached, that improvements in both the yield and age of the cow will have to be achieved

Table 1. Trends in key performance indicators identified across milk recorded herds from 2010 to 2017

Parameter	Median	Median	Top 25 %
Year	2010	2017	2017
Daily lifetime milk yield (kg/ cow/ day)	10.5	12.3	14.4
Lifetime yield (kg/ cow)	25,295	26,937	35,215
Age at exit (years)	6.6	6.0	6.7
Calving interval (days)	424	402	389
Average Somatic Cell Count ('000 cells/ ml)	210	179	145

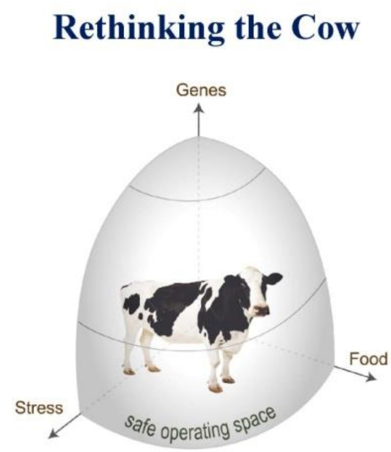
Source: Hanks and Kossaibati (2017)

2.2 What affects lifetime performance?

Many factors will impact on the lifetime performance in dairy cows but reviewing the work of Hanks and Kossaibati (2017) and discussions with Dr Alastair Macrae (Royal Veterinary School, University of Edinburgh) would suggest that improvements in dairy herd fertility management and mastitis management have already been responsible for significant changes in lifetime yield with UK dairy herds in recent years.

If all biological systems are affected by tipping points, this would suggest that there are additional factors which could be influenced to affect performance even further. Work by Scheffer (2017) has suggested that stress created within the cow's environment will have a detrimental impact on cow performance (Figure 1). As transition cow management, heifer rearing and breeding policies can all impact on the stress of an animal and its resultant health status and production potential it seems logical to examine the impact of these factors in more detail on the lifetime performance of a dairy cow

Figure 1. Tipping points to test the resilience of dairy cow performance



Source: Scheffer (2017)

The following chapters will describe my findings on the potential impact of transition cow management, heifer rearing policy and breeding technologies on lifetime performance and assess the implications for adopting the technologies associated with these areas to achieve a lifetime performance of 50,000 l/ cow

3.1 Transition cow management

The transition period in the production cycle of the dairy cow refers to the period immediately before and after calving. In recent years increasing effort has been placed on assessing the impact of transition cow management on dairy cow performance. The following section will summarise the main findings from my study tour in this area

3.1.1 Importance of transition cow management

Traditionally transition cow management dealt with a period from 3 weeks before calving to 3 weeks post calving and received relatively little attention in comparison to other aspects of dairy herd management. However work carried out in recent years would suggest that the transition period should now cover a timespan starting at drying off and continue through to at least one month after calving. In addition the management strategy adopted at this stage has been shown to have a major impact on the production performance of a dairy cow post calving with potential implications on her lifetime performance. Some significant findings in the area of transition cow management have been made at the University of Guelph, Ontario, Canada by Drs Stephen LeBlanc and Trevor DeVries, so I decided to visit the University to discuss the subject with these individuals in more detail as well as attend an International Symposium on transition cow management at Wageningen UR in the Netherlands and discuss the subject with Dr Gordie Jones (Central Sands Dairies, Wisconsin, USA)

Discussions with Stephen LeBlanc revealed that only 56 % of dairy cows in North America came through the transition period without any health problems. Affected cows at this stage had increased problems post calving with issues such as poorer milk yield and fertility which led to an increased risk of culling for affected animals. Stephen also added that he felt that this was a global issue. The challenges posed by transition cow management can also have a major economic impact on the dairy business as a presentation by Dr John Feltrow at the International Symposium showed that transition cow disorders on average in the current economic climate cost a dairy business around £80/ cow but that this could range from £40 - £120/ animal

3.1.2 What happens during the transition period?

The transition dairy cow goes through a series of significant hormonal, metabolic, immunological and physiological changes resulting from:

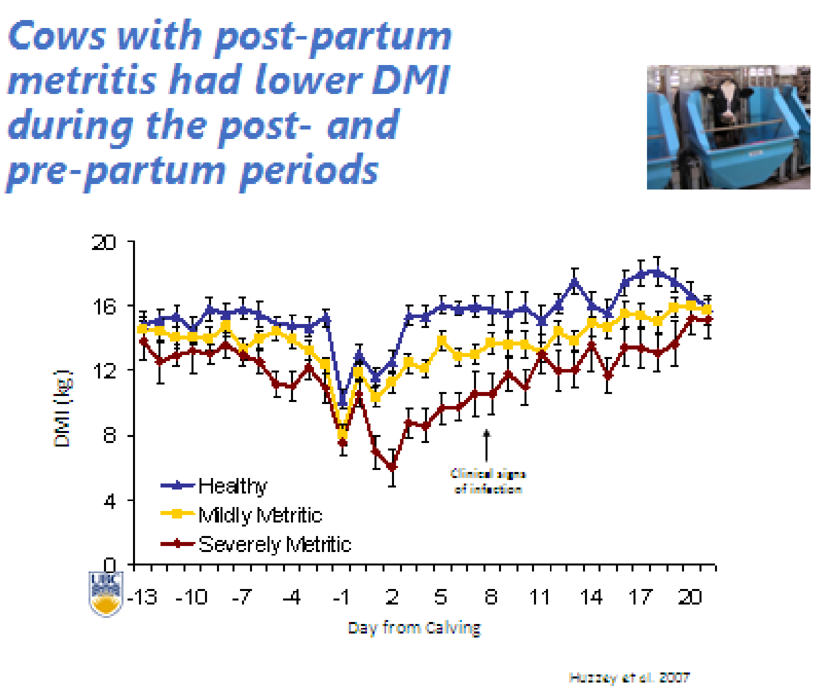
- Foetal growth
- Parturition
- Initiation of lactation

In addition dairy cows experience dramatic metabolic changes during transition which if not managed appropriately can result in:

- Negative energy balance
- Hypocalcaemia
- Immunosuppression and transition cow disorders

Stephen LeBlanc and colleagues at the University of Guelph have also found that changes in the feed intake patterns of dairy cows as they approach calving have a major impact on the development of transition cow disorders. All cows will experience a reduction in intake at this stage. However cows that ate 1 kg DM less than average at this stage were 2X as likely to develop ketosis and 3X as likely to develop metritis (Figure 2). The two main transition disorders which Stephen was focusing on were hypocalcaemia and ketosis. Additional disorders that may arise at this stage include the onset of displaced abomasum (DA), retained placenta (RP) and metritis which can develop separately or more likely as a result of the cow developing hypocalcaemia or ketosis and it is these latter disorders on which the report will focus on primarily

Figure 2. Effects of changes in feed intake at calving on metritis in dairy cows



Source: LeBlanc (2017)

3.1.3 Hypocalcaemia

Hypocalcaemia or milk fever is a metabolic disorder observed among dairy cows close to calving caused by low blood calcium. All cows experience a reduction in blood calcium at calving. However work by Stephen across a range of dairy herds had shown that cows which develop milk fever have a larger reduction in serum calcium and that cows with a serum calcium concentration of ≤ 2.1 mmol/ l were particularly at risk of developing the disorder. In addition cows suffering from hypocalcaemia had reduced milk yields at their first recording (2.6 kg/ cow/ day), reduced levels of fertility, an increased risk of developing a displaced abomasum and a reduced immunological status.

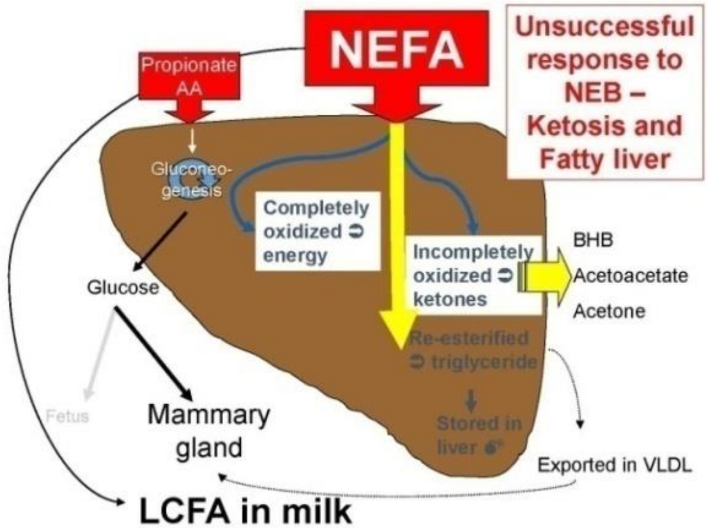
Affected animals may be treated with calcium supplements. However it is believed that such supplements have only a modest and short term effect in the immediate post treatment period and that preventative measures were more effective in the long run. Stephen suggested putting measures in place that ensured that the drop in feed intake was minimised in the period approaching calving and that diets fed at this stage were formulated to ensure that a drop in blood calcium was minimised. The approach that he suggested was to formulate a diet according to dietary cation anion balance (DCAB) with a target DCAB of <-100 meq/ kgDM, which is already being used as an approach in the UK.

3.1.4 Ketosis

Ketosis is a metabolic disorder that occurs in dairy cows where energy demands exceed energy intake and a negative energy balance results. The cow attempts to compensate by mobilising body fat which is utilised by the liver as non esterified fatty acids (NEFA). The liver can metabolise NEFA by full oxidation of fatty acids to CO_2 by the formation of ketone bodies or by esterification and release of very low density lipoproteins (VLDL). However if the liver is unable to process these pathways completely, due to a lack of energy, the excess material accumulates as ketone bodies (Figure 3), which results in ketosis or subclinical ketosis (SCK). The resilience of the dairy cow to deal with ketosis or SCK can be assessed by measuring the concentration of ketone bodies such as NEFAs or beta hydroxy butyrate (BHB).

Work by Stephen LeBlanc and colleagues has shown that cows exhibiting high concentrations of NEFA (>0.4 mmol/ l) in the last 7 – 10 days before calving were associated with a 2 – 4 X increased risk of developing a DA, a 2X increased risk of developing a RP as well as a reduction in milk yield and an increased risk of culling. In addition cows that developed ketosis/ SCK were 2 X as likely to have a recurrence of this disorder as cows that did not, leading to more potential difficulties in the future. Stephen also felt that SCK was a problem among dairy herds across the world, with issues with SCK in dairy cows reported in North America, New Zealand and Europe.

Figure 3. Pathway Showing the Build Up of Ketone Bodies



Source: LeBlanc (2017)

Cows exhibiting signs of elevated ketone bodies post calving (BHB > 1.2 – 1.4 mol/ l) presented similar issues and also had an increased risk of developing metritis and other fertility issues (Table 2). Reductions in the immunological status of affected cows also had implications for other disorders such as mastitis which in turn could result in an increased risk of culling. Overall lactation performance could be affected by up to 650 kg/ cow

Table 2. Impact of ketosis on reproduction

Degree of ketosis	Median time to pregnancy (days)	Conception rate to first service (%)
None	108	42
Developed week 1 post calving	124	36
Developed week 2 post calving	130	28

Source: LeBlanc (2017)

Cows diagnosed with ketosis can be treated with 300 g/ cow/ day of propylene glycol and glucose for up to up to 5 days to address the issue. However Stephen was keen to highlight a programme which was designed to prevent the problem arising.

A checklist which outlines the main features of this programme is given below. These included:

1) Keeping effective records of all transition cow disorders and benchmarking them against industry standards. Target rates of incidence for these disorders included:
   a. < 5 % ketosis
   b. < 5 % milk fever
   c. < 3 % DA
   d. < 10 % RP
2) Monitoring cows for elevated levels of ketone bodies
3) Creating an environment that ensures that drops in feed intake approaching calving are minimised (*ad libitum* feeding, ≥ 75 cm feed space/ cow)
4) Creating a series of diets that meet the nutrient requirements of the transition cow at various stages of the transition period

Ensure that there is adequate feed space available in the transition cow accomodation

Transition Cow Checklist

Goal: Optimize metabolic health and immune function; Means: Manage cows to maintain feed intake

Management

- Feed daily for 3-5% left over; ideally ≥ 2X/day
- ≥ 75 cm feed bunk space per cow
- ≤ 85% cows: freestalls
- > 11 m^2 of bedded pack/cow
- > 5 m^2 of shade/cow; >55 m^2 of drylot
- Build for 130-140% of average monthly calvings
- Large enough stalls; adaptation
- < 24 h in calving pen
- Minimize group changes
- Separate heifers if it does not violate the above
- Heat abatement (fans, soakers) when THI > 68
- BCS = 3.0 - 3.5 at calving

Transition diet

- 3-4 weeks on close-up diet or 6 weeks as 1 dry group
- Meet but do not exceed energy requirement 8 to 3 weeks prepartum
- Water *ad libitum*; 10 cm linear per cow; 2 sources per pen
- ≥1000 IU vitamin E/day; up to 2000 IU/day for RP; 0.3 ppm selenium (Ideally ~ 6mg/day)
- DCAD < -100 mEq/kg; Urine pH < 6.5

Monitoring

- NEFA < 0.3 – 0.4 mmol/ l l last week prepartum, < 0.7 – 1.0 mmol/l in week 1
- BHB < 0.8 mmol/ l in week -1
- BHB < 1.1 mmol/ l in week 1
- BHB < 1.2 mmol/ l in weeks 2 – 3
- Ca > 2.15 mmol/l in week 1

Discussions with other nutritional consultants have suggested that they agree with the proposed approach albeit with some modifications. For example, Dr Gordie Jones (Central Sands Dairies, Wisconsin) was also concerned about how reductions in feed intake among cows approaching calving affected their lactation performance. In addition to some of the steps outlined in the checklist, Gordie suggested that 50 % of a transition cow's diet approaching calving should be derived from forage fibre or forage neutral detergent fibre (NDF), which should amount to approximately 6 kg NDF/ cow/ day, which by coincidence appeared to be about the same amount that an early lactation cow would eat. Gordie has adopted this approach both on his and on clients' dairy units and has observed that cows on this diet tend to eat more in the close period to calving and this in turn had a positive impact on the performance of cows post calving.

While some of the points given in the Transition Cow Checklist, in particular the recommendations for body condition score and the points referring to heat abatement and shade, may refer specifically to dairy herds managed in North America, the vast majority of points listed could be implemented within transition cow groups being managed in the UK. Indeed many of the points listed have already been incorporated into the management programme of transition cows in the CAFRE Future herd and it is interesting to note that recent measurements taken with transition cows in the Future Herd showed that these cows had an average forage NDF intake of 6 – 7 kg/ cow/ day (Boyle and Mulholland, personal communication)

In all cases, it was stressed that minimizing the drop in feed intake in the close up period to calving was critical in minimizing the risk of transition cow disorders, rather than just maximizing feed intake

3.1.5 <u>Setting up a monitoring programme</u>

Discussions with Stephen LeBlanc would suggest that monitoring the concentration of ketone bodies should be an essential component of any dairy management programme to prevent incidences of ketosis or SCK. Stephen suggested that a minimum of 12 cows should be tested within a 100 cow herd, but would have greater confidence in the results if 30 cows could be tested. Stephen also suggested that this approach should be taken across at least 100 dairy herds in the locality to identify any potential industry trends.

While it is difficult to measure NEFA concentrations in cows within a commercial set up, levels of BHB in freshly calves cows can be measured effectively using a range of commercially available tests which include milk testing kits, urine testing kits and blood testing kits. Examples include Keto Test (milk), Ketostix (urine) and Precision XTRA (Freestyle Neo) or Portacheck (blood). Other testing kits for blood, milk and urine are also available.

There has also been some interest in the industry in measuring changes in milk fatty acid composition as a means of identifying cows at risk of developing ketosis. Trials have shown that changes in the fatty acid profile of milk are related to dietary changes, milk fat depression and indeed negative energy balance. There is also growing interest in the use of activity monitoring systems. The monitoring devices are worn around the neck of the cow or in one of her ears and they measure changes in activity such as rumination. A number of studies have attempted to assess this technique and in some cases have shown that reductions in the rumination patterns of cows can be related to the onset of disease and that this can be detected a number of hours or even days before physical symptoms appear. When asked about this Stephen LeBlanc thought that both technologies showed some promise as a potential diagnostic tool for detecting transition cow disorders. However he concluded that a significant amount of work is still required to be carried out before either of these techniques could be used as an effective diagnostic tool and that work continues both in North America and in the Netherlands

Cow wearing an activity monitor in her ear

3.1.6 Management of the fresh cow

Work is also ongoing in examining how management strategies impact on the performance of dairy cows in the first 30 days post calving (fresh cow). One of the main challenges facing the industry in recent years is that of maximizing the feed intake of these animals in order to reduce the effects of negative energy balance and improve the resultant health status of the cow

Dr Trevor DeVries (University of Guelph) has been carrying out research in this area and in particular has been examining how monitoring and optimizing animal behavior can be achieved to maximise feed intake. Trevor's findings to date are as follows:

- Management of the feed should be focused on increasing opportunities for cows to go to the feed bunk each day. This can be achieved by:
    - Creating adequate feed space (minimum of 60 cm/ cow)
    - Delivering feed more than once a day
    - Altering the timing of feeding. For example, Trevor has noted that offering feed approximately 3 hours after milking will stimulate additional feeding activity
    - Feed push ups during the day will also help to stimulate feeding activity, although Trevor did have some concerns that the effects associated with feed push ups may only be noticed if there was a lack of feeding space there already
- Fresh cow diets should also be formulated to maximize eating time and feed intake

Using these techniques also reduced the risk of dietary sorting, where cows select the concentrate portion of a diet in preference to long forage and in doing so reduce the risk of cows developing a dietary disorder known as sub acute rumen acidosis (SARA). Cows affected by this disorder can produce milk with a lower butterfat content and Trevor's work appeared to confirm this. For example, work by Trevor across a range of commercial dairy herds showed that increases in the feed space allowance of 10 cm/ cow led to an increase in butterfat concentration of 0.06 % and a 13 % reduction in somatic cell count.

Trevor's work is ongoing with new facilities at the University that will allow him to measure individual feed intakes of cows at any time of the day

Recent installed feed intake facilities at the University of Guelph

3.1.7 <u>Commercial uptake</u>

The commercial herds that I visited during my study tour all took the subject of transition cow management very seriously. For example, at Milk Source Dairies, Wisconsin, dry cows were allocated into 2 groups (far off and close up) according to stage of dry period. Cows in transition groups were stocked at < 85 % stocking density. Animals were fed a diet specifically formulated for cows at this stage of production for 45 – 50 days and a diet with a DCAB content < -100 meq/ kg DM in the 3 weeks approaching calving. Cows were then moved to a fresh cow pen for the first 21 days post calving, where feed intakes were measured and physical checks were carried out daily. Incidences of transition cow disorders were monitored and compared against BHB measurements which were taken monthly.

A similar approach to transition cow management was also taken at other dairy units that I visited including Summitholm Holsteins, Ontario, River View Dairy, Minnesota and Rosy-Lane Holsteins, Wisconsin. Additional measurements were also taken at Rosy-Lane Holsteins, where they assessed milk produced/ cow in relation to level of feed consumed. Currently this figure had been estimated to be 1.7 l milk/ kg DM feed intake, which was higher than the average recorded in Wisconsin at the time (1.4 l milk/ kg DM feed intake). However if the figure decreased at any stage then a major review of both transition and fresh cow management in the herd was carried out to identify and address any issues which appeared

Transition cow group, Rosy-Lane Holsteins

3.1.8 Is there a need for a dry period?

An alternative and some might suggest radical approach to transition and dry cow management is being investigated by research staff at Wageningen UR in the Netherlands. Dr Ariette van Knegsel is assessing the impact of different lengths of dry period on cow performance by subjecting cows to a standard dry period (60 days, 60 DP), reduced dry period (30 days, 30 DP) or no dry period (0 DP). The proposed benefits associated with this approach included:

- An improved energy balance post calving which may improve the animal's metabolic and fertility status and perhaps longevity
- Omitting the dry period may eliminate the need for sophisticated dry cow management strategies as outlined earlier
- Omitting the dry period reduces the need for dry cow therapy/ dry cow antibiotics (selective dry cow therapy) which in turn could reduce veterinary costs and possibly reduce the risk of developing microbial resistance to antibiotics

The main findings of Ariette's work to date were as follows:

1) Reducing or omitting the dry period led to a significant reduction in milk yield of cows (Table 3). The degree of the reduction appeared to be larger for first lactation heifers going into second lactation as opposed to older cows, where the effect was reduced. On farm studies have reported similar trends, although higher reductions have been reported in some individual cases. There was no information available to date on the effects of omitting the dry period on lifetime yield.

Table 3. Effect of reducing or omitting the dry period on milk production

	Length of dry period		
	0 DP	30 DP	60 DP
Parity 2			
Milk yield (kg)	9,164	10,898	11,110
Parity > 2			
Milk yield (kg)	9,601	10,325	10,775

Source: van Knegsel (2015)

2) The milk production profile also changed as cows produced less milk in early lactation but more in late lactation. This has led the team at Wageningen UR to propose a new method of comparing milk yield between dry period lengths called "effective lactation yield". This is defined as the daily yield from 60 days before calving to 60 days before next calving
3) The energy balance of cows with a reduced (30 DP) or omitted dry period (0 DP) was significantly higher than cows given a standard dry period (60 DP). However this effect was less pronounced in cows that did not experience as big a reduction in milk yield with a reduced or omitted dry period.
4) These changes have also been found to coincide with a change in metabolic status (lower plasma BHB) and improvements in herd fertility. For example, cows in the 0 DP group had higher levels of cyclical activity and a lower calving interval than cows in the 60 DP group.
5) Milk produced by cows with a reduced or omitted dry period produced colostrum with a lower immunoglobulin (Ig) concentration than cows with a standard dry period. While calves fed this colostrum to date have been found to have lower levels of serum Ig than calves fed regular colostrum, growth rates between both groups have been similar
6) Milk produced by cows from the 0 DP or 30 DP groups appeared to have a higher somatic cell count (SCC) although there was some debate as to whether this was a treatment effect or volume related effect
7) Not all cows that underwent no dry period in one lactation were found to be suitable to repeat the process in a subsequent lactation. For example, some cows in the 0 DP treatment were found to lay excessive amounts of body condition and experienced issues with the persistency of their lactation to the extent that they were omitted from the treatment in the subsequent lactation

Ariette and the team are currently developing a computer application (App) to be used by the industry to identify the most appropriate dry cow treatment for individual cows in terms of dry cow therapy and length of dry period. Factors that are currently being included are:

- Number of lactations
- Milk yield
- SCC

For example, older cows with a higher milk yield and a low SCC (50,000 cells/ ml) may be considered for selective dry cow therapy and 0 DP.

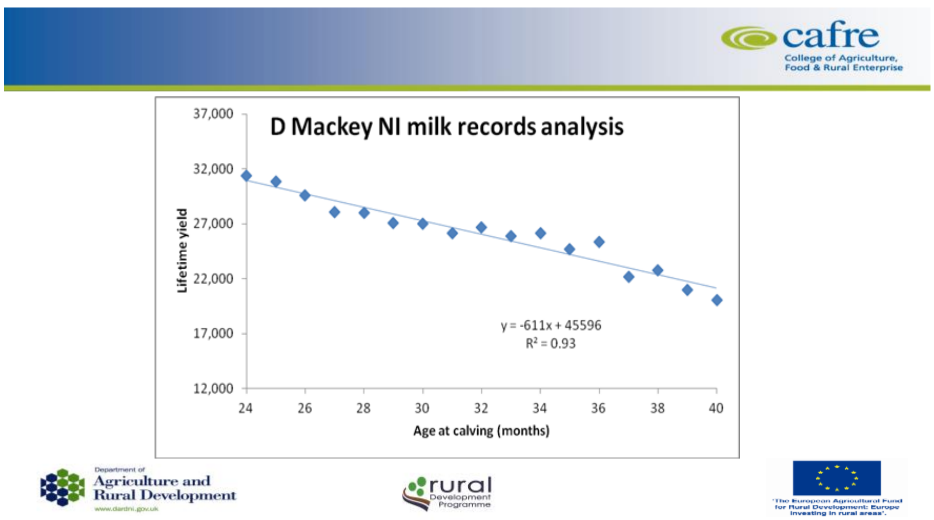
By customizing the dry cow period approach for individual cows, it is believed that this will improve health status across the dairy herd by creating less critical periods in the cow's life in addition to reducing the need for dry cow antibiotics as outlined earlier.

It is proposed that when the application is developed that it will be available in a form to be downloaded onto a user's mobile phone for use in the industry. Feedback from the industry to date has suggested that there is an interest in this subject and that such an application would be useful. Use of such an approach is also assisted by the fact that the vast majority of Dutch dairy herds use milk recording (92 % of the industry) and have up to date information for individual cows on SCC levels

4.1 Effects of heifer rearing on cow longevity

The rearing of heifer replacements on many dairy units does not usually receive the attention it deserves. However the management system adopted with rearing heifer replacements has a major impact on the lifetime performance of dairy cows in a herd. Analysis of milk recording data across a number of countries has revealed that age at first calving (AFC) has a significant impact on lifetime performance, where heifers that calve down at 22 – 24 months age have a longer productive lifespan than animals calving over 26 months age. Indeed analysis of milk recording data from Northern Ireland by CAFRE has shown that for every month's increase in AFC over 24 months, total lifetime production is expected to decline by 600 litres (Figure 4). Similar trends have been observed elsewhere.

Figure 4. Effect of Age at First Calving on Lifetime Performance of Dairy Cows



To reach a target of 24 months AFC, it is important to note that heifer replacements must reach specific weight targets during the rearing process. For example, regardless of breed, heifers should be expected to achieve 55 – 60 % of their mature weight at first service and 82 – 85 % of their mature weight at first calving. In order to achieve these goals within a period of 2 years, a Holstein Friesian heifer is expected to approach or perhaps exceed a target average daily liveweight gain (LWG) of 0.8 kg/ animal/ day to reach a pre calving weight of around 600 kg. Recent research carried out in the United States of America and the Netherlands has suggested that it is possible to achieve this target. Indeed if calves in the birth – weaning stage can achieve a daily LWG approaching 1.0 kg/ calf/ day, then further enhancements in lifetime performance can be achieved. To that end, I arranged to meet Dr Mike Van Amburgh (Cornell University, USA) and staff from Trouw Nutreco (Dr Mark Little) to discuss how pre weaning management could impact on the lifetime performance of dairy cows and what factors would need to be considered in setting up and managing a rearing programme to optimise lifetime performance

4.2 Impact of calf rearing on lifetime performance

Recent research with young calves has shown that the management strategy adopted between birth and weaning can have a major impact on lifetime performance. Studies carried out by Mike Van Amburgh and staff at Trouw Nutreco has shown that calves which achieve an accelerated rate of growth at this stage (approaching 1.0 kg/ calf/ day) or calves which double their birth weight between birth and weaning have increased milk yields and lifespans as lactating cows. In addition, work by Mike Van Amburgh and colleagues has shown that every extra kg of daily LWG achieved by calves in the pre weaning period led those animals to achieve 1,551 kg more milk in their first lactation and 2,279 kg over 3 lactations. Further analysis by Mike revealed that almost 25 % of the variation in first lactation yield could be explained by changes in pre weaning growth rate. When it is considered that selecting for milk yield accounts for 7 % of variation in first lactation yield this merited further investigation

Discussions with Mike indicated that increases in lactation yield appeared to occur because calves undergoing accelerated rates of growth at this stage also underwent increased cellular development with their mammary glands, thereby increasing their potential for enhanced milk production. Mike Van Amburgh suggested the following targets for rearing calves from birth – weaning:

1) Double calf's birth weight by 56 days age

2) Reduce calf mortality < 5 % in the pre weaning phase

3) Maintain calf morbidity treatments < 10 % in this period

However when Mike assessed individual calf data for animals which were all offered the same plane of nutrition, he found differences in growth responses ranging from 0.29 – 1.6 kg in daily LWG for calves during the pre weaning period. Further discussions with Mike Van Amburgh and Mark Little revealed that the following factors are critical in achieving accelerated rates of growth in young calves

- Colostrum
- Rearing environment
- Health status
- Nutrient status

4.2.1 Colostrum

It has been well established that the consumption of adequate quantities of colostrum (10 % of birth weight) is critical in establishing the immunological status of the new born calf. What is now becoming more apparent is that, important as this is, colostrum also provides the calf with much more than immunoglobulins (Ig). This includes growth factors such as IGF-1 or hormones such as insulin which can stimulate growth or other metabolites such as relaxin which have been shown to enhance fertility in pigs.

Mike Van Amburgh has carried out an extensive review of the effects of colostrum on calf performance and was able to show me experimental results which indicated that calves offered only 2 l colostrum at the first feed had lower rates of weight gain through to puberty, poorer levels of feed efficiency and lower milk yields post calving than calves initially offered 4 l colostrum (Table 4)

Table 4. Impact of feeding differing levels of colostrum on cow performance

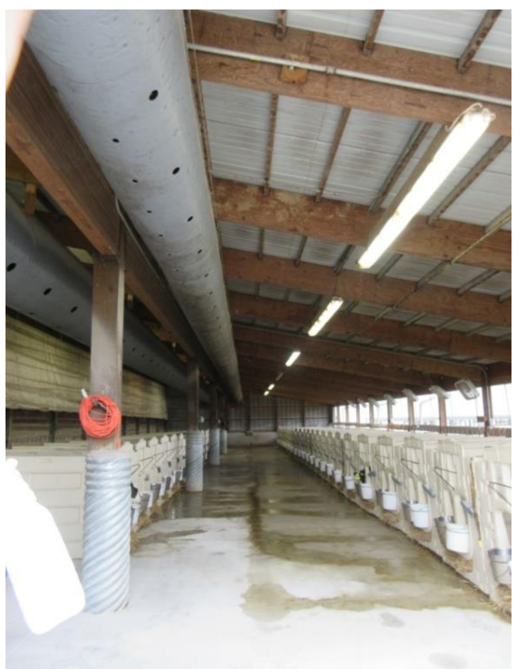
	Quantity of colostrum fed (l/ calf)	
	2	4
Daily LWG (kg/ animal/ day)	0.8	1.0
% survival to second lactation	75.3	87.1
Cumulative milk production to second lactation (kg)	16,015	17,068

Source: Faber *et al.* (2005)

In the light of this information Mike Van Amburgh suggested that calves be fed at least 10 % of their bodyweight immediately after birth and that colostrum continue to be fed for the first four days of life

4.2.2 Rearing environment

It is critical that calves are reared in a warm, clean, dry environment in order for a target daily LWG in excess of 1.0 kg/ day to be achieved. Work at Cornell University has shown that calves less than 40 days age are comfortable in an environment with a temperature between 15 – 28 ^{o}C. However when the temperature dropped below this range, energy consumed by the calf was used to generate heat instead of growth. For example, calves reared under cold, wet conditions were estimated to have a maintenance energy requirement which was 2X that of calves reared under optimal conditions.



Calf rearing facilities at Rosy-Lane Holsteins, Wisconsin

4.2.3 Health status

Maintaining the health status of young calves also has a major impact on the milk production of those animals post calving. For example, Mike had reviewed the subsequent lactation performance of calves that had contracted diarrhea and/ or a respiratory disorder and compared them to healthy calves. Overall he found that calves that had been treated with antibiotics produced 493 kg less milk in their first lactation than healthy calves with no records of being treated. He concluded that sickness caused calves to reduce their intake, which in turn reduced growth rates leading to a loss in productivity. To reduce the risk of calves falling ill, it was therefore essential that they receive adequate supplies of colostrum at birth as outlined earlier (Section 4.2.1) and are reared in a clean, dry and well ventilated environment (Section 4.2.2).

4.2.4 Nutrient status

Achieving increased rates of growth approaching or in excess of 1.0 kg/ calf/ day during the birth – weaning stage represents a major challenge. Discussions with Mike Van Amburgh suggested that calves would need to consume 10 – 12 l whole milk/ calf/ day by 21 days of age to consume sufficient nutrients to achieve this. The practicalities of feeding this amount of milk may pose a challenge on a number of UK dairy farms, although technologies being developed with automatic calf feeding may address this issue. For example, an experiment is being carried out at the University of Guelph to assess whether using an automatic calf feeder fitted to a rail system would encourage calves to drink more milk and whether positioning concentrate at different areas in the rearing pen will encourage intake of milk and feed

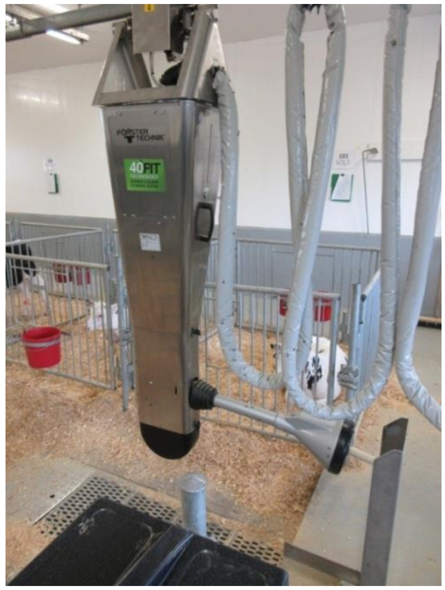
Milk replacers are also being developed which can allow accelerated rates of LWG to be achieved in the pre weaning phase. Work carried out at Cornell University would suggest that calves fed a traditional type of milk replacer with a crude protein (CP) content of 20 % at a rate of 500 g/ calf/ day will find it difficult to achieve these LWG targets. However calves offered around 900 g/ calf/ day of a 28 % CP based milk replacer appear able to reach the target LWG already outlined. Work at Trouw Nutreco has indicated that feeding 900 g/ calf/day of a 24 % CP based milk replacer to calves may be adequate for accelerated rates of LWG. However research by this group would also suggest that the quality of protein added to the milk replacer is important in that the feed should contain adequate quantities of lysine, methionine and threonine and optimum amino acid to energy ratios to enable target LWG to be achieved

Calves should also be offered increasing quantities of concentrate (25 % CP) from a few days after birth and that the quantity of feed offered should increase as the calf gets older and approaches weaning.

4.2.5 Weaning process

Both staff at Cornell University and Trouw Nutreco suggested that calves be weaned around 56 – 63 days of age and that weaning should be a gradual rather than an abrupt process. Concentrate intakes among animals at this stage should be increasing so that calves at the weaning stage are consuming 1.5

– 2.0 kg concentrate/ calf/ day. Forage should be provided separately from concentrate to stimulate intakes of both feeds. Research work is ongoing in this area.



Computerised calf feeder being assessed at the University of Guelph

4.2.6 <u>On farm experience</u>

All the farms that I visited during the study tour were aware of the calf rearing research being carried out and some of the farms had implemented the programme outlined, although achieving the targets could at times present a challenge. For example, calves at Rosy-Lane Holsteins, Wisconsin were reared to achieve a daily LWG of 0.8 – 0.9 kg/ calf/ day in the pre weaning phase using a 28 % CP milk replacer. The resultant average lifespan of cows in the 1,000 cow herd was around 4 years and average lifetime performance was around 54,000 l/ cow. While many factors contributed to this figure, the owners of the herd were convinced that the calf rearing programme was having a significant impact on the performance of their herd.

A similar emphasis on calf rearing was being adopted at Summitholm Holsteins by the Loewith family. The average lifetime performance of their herd was 40,000 l/ cow, although individual animals within the 400 cow herd had achieved 170,000 kg over their lifetime. Interestingly the average AFC for heifer replacements in the herd was 22.5 months. Calves in the herd received 3 l/ calf colostrum at birth plus another 3 l within 12 hours. Calves continued to be offered colostrum for another day after which they were offered increasing quantities of whole milk (up to 10 l/ calf/ day) before being weaned at 56 days of age.

Calves born on larger dairy operations such as Milk Source, Wisconsin were reared in specifically set up rearing units, usually composed of hutches. After weaning the calves were moved to another rearing operation, where they remained until approximately 2 months before calving. The weights of calves both entering site and leaving the site were recorded to ensure that targets were being achieved and that satisfactory management practices were in place

5.1 Breeding technologies

The Holstein breed (HO) has dominated milk production in the United Kingdom and indeed the world over the last 25 years and the success of selection for milk production has contributed to the domination of the HO breed. Nevertheless recent analysis of milk production data has also revealed that the increases in milk production have been accompanied by reductions in fertility and survival rates of cows leading to increased rates of culling. While day to day management factors are contributing to these trends, it is also recognised that breeding and genetics are also having a major impact on the lifespan of dairy cows.

Dairy farmers are attempting to address this issue using a variety of methods. For example, some milk producers have been crossing HO with other breeds in an effort to improve lifetime performance and a significant part of this section will describe what I discovered when I visited some cross breeding programmes in the Republic of Ireland and the United States of America (USA). However while I was travelling I also had the opportunity to discuss the use of other breeding technologies that are being used in the industry to improve health status and lifetime performance, which included genomics and the use of "Immunity +" sires. Therefore I will also describe my findings with these technologies.

5.2 Cross breeding

Cross breeding can be defined as the mating of parents of two or more different breeds or strains or species together. While the practice of cross breeding is widespread within many livestock enterprises, the adoption of cross breeding within dairying systems has been limited. Recently there has been increasing interest among some milk producers in using this method as a means of improving fertility, health and longevity within their dairy herds. Reasons which farmers have started to use cross breeding include:

- Reduction in inbreeding and breed complementarity
- Beneficial effects of hybrid vigour – this describes the additional performance benefits that may be obtained over and above the mean of the two parent breeds. For example, if Breed A has a lactation yield potential of 6,000 l and Breed B has a lactation yield potential of 8,000 l, the offspring from the two breeds may be expected to have a lactation yield potential of 7,000 l. However the actual performance of a cross bred cow is often observed to be in excess of this, with the extra performance attributed to hybrid vigour.
- In addition, while hybrid vigour for milk yield may be 3 – 6 %, traits such as fertility, health and longevity may in certain circumstances have hybrid vigour of up to 20 %

In the light of this information it is possible that adopting a cross breeding programme may help to improve the lifetime performance of dairy cows. However it is important to realise that the greatest benefits associated with cross breeding are observed with the first cross (F1 cross). The extent to which hybrid vigour is expressed after this depends on the strategy adopted after the first cross. Different approaches to cross breeding cows have been adopted in the New Zealand, the Republic of Ireland and the USA. As part of my project I decided to review the practices which have been adopted in the Irish

Republic and the USA to assess what potential implications cross breeding may have in achieving an average herd lifetime performance of 50,000 l/ cow

5.2.1 Cross breeding in Ireland

Extensive studies evaluating the merits of a number of alternative breeds and cross bred animals have been carried out at the Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Ireland. The work has focused primarily on the impact of using cross bred animals within an Irish spring calving system, where cows calve down in late February/ March and make maximum use of grazed grass. Typical average cow performance figures on this type of system are around 4,500 – 5,500 l/ cow/ year from 0.3 – 0.5 t concentrate/ cow/ year.

Friesian and Jersey cow grazing at Teagasc Moorepark

I discussed the issues associated with cross breeding with Dr Frank Buckley, who was primarily involved in the cross breeding research programme at Moorepark. A summary of these discussions were as follows:

1) Survival analysis incorporating data up to 5 lactations indicated increased survival rates and longevity for breeds such as Jersey (JY), Montbeliarde (MO), Norwegian Red (NR) and Normande (NO) and crosses of these breeds with Holstein Friesian (HF) compared to the HF breed
2) Other breeds such as NO had lower milk yields and in other cases the progeny of some crosses, in particular MO crosses had difficulties in reaching calving targets (target AFC of 24 months) required to match a seasonal calving pattern
3) While HF produced a higher milk volume than JY or HF x JY cross, the HF x JY produced a higher fat and protein yield than either parent breed and had superior reproductive characteristics (Table 5)

Table 5. Milk production characteristics for cows of 3 breed types

	Breed Group		
	HF	JY	HF x JY (F1 cross)
Milk yield (kg)	5342	4233	4973
BF %	4.06	5.26	4.72
Protein %	**3.51**	4.04	3.81
Fat + protein yield (kg)	407	392	424
% Pregnant to first service	41	47	62
% In calf rate	51	56	70

Source: Prendeville *et al.* (2011)

4) Analysis of economic data indicated that farms in the Republic of Ireland that adopted a cross breeding programme were at least £90/ ha more profitable than farms that did not
5) Using a third breed such as NR with the F1 cross would help to maintain hybrid vigour. However most dairy farmers who were cross breeding appeared content to continue switching between HF and JY
6) HF x JY crosses appeared to perform best in a low input spring calving system.
7) While HF x JY crosses had longer lifespans than their HF counterparts there did tend to be some issues associated with the udders of these cross bred animals in later lactation. It was therefore critical that the best available genetics (high value EBI sires) were used in a cross breeding programme. In addition having access to a herd genetic report was also critical in identifying any potential issues to be addressed. Factors to be reviewed included:
    a. Fat + protein yield
    b. Fertility
    c. Udder health
    d. Udder quality in particular udder ligaments

Friesian x Jersey cows grazing at Teagasc Moorepark

Further example of Friesian x Jersey cows

Udder quality should be monitored among cross bred cows

5.2.2 Cross breeding in the United States of America

While the vast majority of cows milked in the USA are HO, it is estimated that approximately 10 % of cows in that country have been cross bred with alternative breeds. Examples of breeds that have been used include Jersey (JY), Brown Swiss (BS), Montbeliarde (MO), Normande (NO), Norwegian Red (NR), Swedish Red (SR) and Fleckvieh (FLV). Unlike the Republic of Ireland, most cows in the USA calve down through the year and are managed in a high input concentrate feeding system with maize silage and alfalfa used as sources of forage, although there is some interest in more moderate feeding systems that include grazed grass.

Dr Bradley (Brad) Heins (University of Minnesota) has carried out extensive research on cross breeding programmes within the University and by analysing milk recording data from commercial dairy herds in Minnesota and California. Discussions with Brad revealed that his work had focused primarily on identifying a 3 way cross to optimise milk production, health and longevity among dairy cows in both high input concentrate feeding systems and moderate feeding systems which included grazed grass. Use of a 3 way cross was found to allow hybrid vigour to be maintained around 85.5 % as opposed to 66.6 % in a 2 way crossing programme.

Early research work had indicated that MO, SR or NO cross bred cows had better lifetime milk yield, fat + protein yield and cow longevity than pure HO cows (Table 6). In addition, while HO had a greater daily lifetime profit, cross bred animals had a greater total lifetime profit.

Table 6. Comparision of cross bred cows with Holstein cows on lifetime production

		Breed	
Trait	HO	MO x HO	SR x HO
Milk yield (kg)	28,086	32,891	31,276
Fat + protein yield (kg)	1,867	2,268	2,157
Days of herd life	937	1,150	1,092

Source: Heins *et al.* (2012)

Work that has been carried out since would suggest that the optimum crossing pattern for higher input feeding systems would involve HO x MO x Viking Red (VR). The latter breed was recently formed as a result of combining genetic improvement programmes for Swedish Red, Finnish Ayrshire and Danish Red herds which historically shared genetic material and placed similar selection criteria with emphasis on the fertility and health of cows. The programme is also known commercially as the Procross programme.

Cross bred cow (5/8 Holstein) and Holstein on high input feeding trial at University of MInnesota

The performance of cross bred cows were being assessed on both low and high input feeding systems at the University. For example, cross bred cows on a grazing trial at the experimental station in Morris, Minnesota were being fed a flat rate of 3.2 kg concentrate/ cow/ day through the season and had averaged 29.5 kg milk/ cow/ day in May and 20.5 kg milk/ cow/ day in July. In another feeding trial at the main Campus in St Paul, where HO and cross bred cows were being offered 9 kg concentrate/ cow/ day plus maize silage and alfalfa haylage, animals were averaging 41 kg/ cow/ day. In all cases cross breeding patterns for each cow were recorded and monitored to ensure that the correct sires were used at each stage.

Cross bred cow on low input feeding trial at University of Minnesota

Further discussions with Brad indicated that while the HO x MO x VR pattern was the preferred option for most systems of milk production, there may be some merit in adopting a JY x NO x SR pattern for low input systems involving the use of grazed grass. However replacements bred from NO crosses tended to have an average AFC greater than 24 months, which could have implications for systems relying heavily on seasonal calving patterns

Example of Normande cross breed

The effects of the Procross programme are currently being assessed on 8 commercial dairy units across Minnesota. Results from the initial crosses on the performance of first lactation heifers have been analysed and published. A summary of these findings is given in Table 7.

Table 7. Comparison of milk production characteristics of cross bred cows with pure Holstein cows

	Breed Group		
	HO	MO x HO	VR x HO
Age at first calving (months)	23.9	23.8	23.7
Milk yield (kg)	10,970	10,954	10,537
BF %	3.74	3.83	3.93
Protein %	3.05	3.14	3.19
Fat + protein yield (kg)	741	760	749
Days to first service	71	69	70
Days open	125	113	117
Conception rate (%)	38	46	43
Survival to second calving (%)	80	84	83

Source: Hazel *et al.* (2017 a,b)

Analysis of the results to date indicated that HO and MO x HO animals produced a similar milk volume. However MO x HO had a higher fat + protein yield and there was also some improvement in herd fertility measurements compared with HO. VR crossed animals also showed some improvements in fertility in comparison to HO. In addition a higher proportion of cross bred cows survived to the second lactation than HO

It was also found that while MO sires bull calves experienced a higher calving difficulty than their HO counterparts, 3 breed cross bred calves from both cross bred first lactation heifers had a lower stillbirth rate than pure HO calves.

I got the opportunity to visit one of the farms which was being managed in the trial (Brookside Dairy), which contained 500 cows managed by its owner Ken Hebranson. Ken had decided to adopt a cross breeding programme because of difficulties he had encountered in managing HO breed and in selling pedigree livestock from his herd. Cows were fed a diet composed of maize silage, alfalfa and concentrate. The breeding programme revolved around the HO x MO x VR pattern outlined earlier. Breeding patterns were recorded and maintained on a computer based recording package (Dairy Comp), which could also be accessed through an application on his mobile phone. Ken was interested in maximising milk volume and average milk yield/ cow that day was 41 kg/ cow. He also reported similar improvements in fertility as highlighted in Table 7 and a reduction in veterinary costs as a result of cross breeding. One additional benefit in cross breeding that Ken was keen to highlight was in higher value calf sales, where cross bred calves sales averaged £200/ calf more than HO calf sales.

I also visited another dairy unit where cross breeding was used extensively (New Heights Dairy) which was managed by Brent Czech. The 1,600 cows in this herd were not involved in the trial mentioned earlier and a 3 way cross based on HO x JY x MO was used to breed cows in the herd, which differed from the pattern highlighted earlier. Breeding patterns were recorded and monitored using the same software as used in Brookside Dairy. Brent had decided to use JY instead of VR, because he believed that this would produce a smaller animal with better udders and components which he felt would be easier to manage in the long term. Some of the first lactation heifers in the crossing programme did produce animals of varying size, although these differences were not as visible by the time the animals had reached their third lactation. Cross bred cows in the herd had an average milk yield of 38.5 – 41 kg/ cow/ day. Recombinant bovine somatotrophin (rbst) was being given to cows at the time to boost milk yields, although its use was being phased out of the herd. Cross breeding also appeared to be having some benefits on fertility with average days open for cross bred cows of 104 days compared to 115 days for HO

Holstein x Montbeliarde x Viking Red cow (Brookside Dairy)

Selection of cross bred cows (Brookside Dairy)

Jersey cross bred cow (New Heights Dairy)

Other comments from both Brad Heins and the farmers I visited about factors to consider when cross breeding included:

1) It is critical that accurate breeding records be kept in a three way crossing programme. It is not possible to identify the appropriate breed sire by looking at the cow
2) Use the best sires available within each breed
3) Focus on dairy characteristics within sire selection, including udder depth
4) Avoid crossing MO crosses with breeds such as FLV or BS as the resultant crosses may produce very large progeny
5) While the initial benefits associated with cross breeding may be seen with calves, it may take up to 5 – 6 years for the full benefits to be observed
6) There was little opportunity to see cross bred cows that were dry. However some of the MO crosses that I did see in the dry cow accommodation did appear to carry a lot of body condition which could have implications for post calving performance. It was suggested that the diet fed at the time was a contributory factor. Therefore feeding management of these animals in the dry and transition period needs to be considered

5.3 Genomics

Genomics is the study of the entire set of genes found in living organisms. It differs from genetics in that genomics looks at all the genes and how they interact to influence the growth and development of an organism. All genetic information is located within a chromosome and among the chromosome are Single Nucleotide Polymorphisms (SNPs) which contain genetic sequences that occur commonly within the population. Genomic information comes from tests (SNP Chips) based on tissue samples taken from an individual animal. The procedure tests for specific nucleic acids at uniformly distributed sites across the chromosome. The initial test across 50,000 sites is used to identify which chunks of DNA get passed from the parents and using phenotypic data from a reference population this is then converted into an index called the genomic predicted transmitting ability (GPTA). The reliability of a genomic sire prediction (70 – 80 %) is lower than that gained with a full progeny test (85 – 90 %). However this limitation can be overcome by spreading the risk and using more sires (at least 8 bulls) than what traditionally would have been used in a breeding programme

The advantage of using genomics is that it can speed up the rate of genetic progress within a dairy herd by providing genetic information at an earlier stage than that gained with a full progeny test. For example, studies at the University of Wisconsin have shown that a sample taken from a young calf can then be used to predict its potential performance as an adult animal for a range of factors including longevity. Dairy operations such as Milk Source Dairies, Wisconsin are already using genomics to identify heifer calves with a potential for increased lifespan, so that they can concentrate on rearing and bringing these animals into the milking herd and allow for a more targeted breeding approach of stock in the herd. Animals which are identified as having a lower value are used as recipients or are sold. The cost of the test has also decreased significantly from £200/ test to £35/ test, making it more attractive to be used among commercial dairy herds

Research into genomics is ongoing with new traits for selection being identified including disease resistance, improved feed efficiency and reductions in greenhouse gas emissions and in reducing the incidences of transition cow disorders. The majority of genomic information is found among HO, although some information is available for JY, Guernsey (GY) and BS breeds. Those individuals using the technique would claim that using genomics is a superior way of increasing the rate and range of genetic gain within a dairy herd than that achieved through cross breeding. Indeed while sires in a cross breeding programme may be genomically tested, it is not currently possible to genomically test cross bred female stock

5.4 Immunity +

During my stay at the University of Guelph, I had the opportunity to speak to Dr Steven Larmer (Semex) about the "Immunity +" sire programme currently being marketed by Semex

Immunity + is based on research carried out at the University of Guelph, that allows animals to be ranked on their immune status through measuring specific antibodies. Sires are injected with a test antigen on day 0 and tested for bacterial and viral antibodies on day 14. The results are then used to calculate a value which is benchmarked against a threshold value. Sires with the highest values are classified as High Immune Response (HIR) sires. The heritability of this trait has also been estimated to be around 25 %, thus suggesting potential for this trait to be carried over to any resultant offspring. There are currently around 70 – 80 Immunity + sires available through Semex, which is the only company through which this technology can be accessed. The majority of these are HO sires, although there are also some JY and Ayrshire (AYR) sires available.

Using sires with an enhanced immune response may therefore improve the longevity of resultant dairy cows in a herd and lifetime performance. Steven has been monitoring the performance of heifers and cows produced using Immunity + sires across 70 commercial dairies and has recorded the following responses to date:

1) 13 % less mortality among heifer replacements from birth – calving derived from Immunity + sires
2) First lactation heifers produced from Immunity + sires have 5 – 20 % less incidences of disease than animals produced from other sires
3) Immunity + sired animals responded better to commercial vaccines
4) Immunity + sired animals also produced better quality colostrum

Immunity + sires are currently only sold through Semex. Uptake of the product has been considered to be satisfactory by the company with almost a three fold increase in the sales of Immunity + sires since the programme was launched in 2012. Steven also speculated that genomic technologies could be used to further refine and speed up the rate of development within this programme leading to an increased range and availability of sires.

6.1 Practicalities of managing cow longevity

When visiting the University of Guelph and Wageningen UR, I also had the opportunity to speak to Dr David Kelton and Dr Yvette de Haas respectively about the consequences of improving cow longevity. In both cases discussions revolved around identifying appropriate management strategies for improving lifespan. The following points were raised:

1) Improving lifespan of dairy cows is desirable in many herds as it can result in reduced culling rates and replacement rates but - is improving longevity a management outcome or management goal?
2) Does improving cow longevity restrict genetic improvement in a dairy herd? Improving lifespan in a herd may reduce the number of heifer replacements entering the herd with potentially superior genetics to existing animals
3) Can we improve persistency of lactation and achieve the same impact with lifetime production?
4) Improving longevity can decrease replacement costs but profit is more important

It is possible that a dairy herd with good reproductive performance, an excellent heifer rearing programme and approximately 50 % female offspring will be entering the herd two years later. This means that about 50 % of the herd will need to be sold each year. The herd manager then has to make a decision on which animal to sell.

Discussions with David, Yvette and some herd managers appeared to suggest that the most appropriate way to address this issue was to identify the best cows within the herd, possibly through using genomics and breeding replacements from these cows. The remaining cows could be bred with beef sires and the resultant progeny sold or transferred to a beef enterprise on the farm. Alternatively all the cows could be bred as before and the resultant heifers could be assessed with the top 15 % kept on farm and the remainder sold. This approach was being used in one of the cross bred herds that I visited (Brookside Dairy) where using genomics was not an option.

David Kelton and staff at both the Universities of Guelph and Minnesota have also developed a computer based model that attempts to predict when a cow should be replaced within a dairy herd. The "Cow Value" model (COWVAL) calculates the "net present value" of each cow which is an estimate of the cow's future income and expenses, then discounts the cashflow to today. The COWVAL is the expected net present value compared to the average replacement heifer. Using the principles outlined by David, a fresh heifer will have a COWVAL of approximately £1,000, assuming a replacement cost of £1,400 and a cull value of £400. The model attempts to answer three fundamental questions:

1) Should this cow be replaced with a new heifer?
2) If this cow is ill, should she be treated or moved on?
3) If this cow is in heat, should she be bred, or should inseminations be stopped?

If a cow is shown to have a negative COWVAL, then replacing her would likely be more profitable.

In other cases, a cow that is diagnosed with a displaced abomasum and a corresponding COWVAL of £950 may be more profitable treated than shipped. Alternatively a cow shown to have a repeat mastitis case and a COWVAL of £100, may be considered a candidate for replacement.

Once COWVAL is estimated a second model is run to determine the change in COWVAL if it is assumed that that animal was successfully bred today. The change in value is referred as the PregValue (PGVAL). Alternatively if the cow is already pregnant, the PGVAL refers to the change in COWVAL if the animal aborted today. A typical PGVAL for an open cow was estimated to be around £160, which meant that getting the average cow pregnant was worth £160. This figure could however vary according to stage of pregnancy.

However if an open cow had a negative PGVAL, this meant that she was worth less as a pregnant animal than open and should not be bred

A range of factors have been included in the model in an effort to estimate the future profit of a cow until she is replaced. Use of the model has been evaluated on commercial dairy units in Ontario and it was found that while cows with the lowest COWVAL tended to be culled, there were difficulties in accurately measuring COWVAL in early lactation (0 – 60 days in milk) as there were large variations in COWVAL within cows and across lactations**.** It was recommended that COWVAL should be reviewed on a regular basis and that dairy producers should use additional information in conjunction with COWVAL during the early lactation period before making a decision on whether or not to remove a cow from the herd.

7.1 Discussion

Improving the lifetime performance of dairy herds in the United Kingdom would have a number of positive benefits for the dairy industry which include:

1) Improved dairy herd profitability through reductions in replacement rate. For example, figures taken from CAFRE benchmarking and AHDB Milkbench+ show that replacement costs on average account for around £220 - £240/ cow but in some cases may be in excess of £450/ cow. Assuming an average UK dairy herd size of 142 cows, this could represent a difference of almost £32,000.
2) Reductions in environmental pressures associated with dairy units through improvements in nitrogen and phosphorus use efficiency and reductions in greenhouse gas (GHG) production
3) Improvements in the public perception of the dairy industry in terms of improved animal welfare through better health status, reduced antibiotic use and longer lifespans with dairy cows

A review of existing NMR milk recording data has shown that the average lifetime performance of dairy herds in the UK is approximately 27,000 l per cow (12.3 l/ cow/ day) over 6 years with the top 25 % of herds achieving around 35,000 litres per cow (14.4 l/ cow/ day) with a corresponding age of 6.7 years. If one were to extrapolate these figures and speculate on how a 50,000 l herd average were to be achieved, a number of scenarios could be generated, including the examples shown in Table 8

Table 8. Possible scenarios on how a 50,000 l herd average could be generated

Scenario	A	B	C
Age (years)	7.7	8.7	9.7
Lactations	5.0	6.0	7.0
Lifetime yield (l/ cow/ day)	17.8	15.8	14.2
Total lifetime yield (l)	50,000	50,000	50,000

In each case, it is assumed that herd life has been extended, albeit to different degrees, but that daily lifetime performance of the cow has altered. Each scenario presents its own challenges. For example, in scenario A, average daily lifetime yield would have to increase by almost 45 % from its current position in order to reach the figure shown. While the daily lifetime yield presented in Scenario C is similar to that already recorded among the top 25 % of herds analysed by Hanks and Kossaibati (2017) and a suggested target by Whitaker *et al.* (2004), it could also be argued that extending the average age of the herd to almost 10 years per cow could have detrimental implications in terms of limiting the introduction of superior genetics into the herd and limit profitability. Work by David Kelton and colleagues at the University of Guelph would appear to support this as they are developing decision support programmes aimed at identifying the optimum time to remove a cow from the herd from an economic viewpoint.

It should be noted however that significant changes in animal performance have already been recorded in recent years, with a 17 % increase in daily lifetime yield recorded by Hanks and Kossaibati (2017) between 2010 and 2017. In the light of this information, perhaps a scenario involving A and B could be created more easily to achieve a herd production average of 50,000 l per cow, where milk production and lifespan have increased, but not to the extent where the rate of genetic progress is compromised.

As mentioned earlier (Section 2.1), improvements in lifetime production are ongoing and appear to be a result of changes mainly in dairy herd fertility and mastitis management. The question remains as to what role transition cow management, calf rearing and cross breeding can play in helping to achieve a herd average of 50,000 l/ cow

7.1.1 Impact of transition cow management

The management programme adopted with a dairy cow during the transition period will have a major impact on its production performance. Cows suffering from hypocalcaemia and/ or ketosis are at greater risk of developing other disorders such as metritis, displaced abomasums or retained placentas which have an additional impact on cow health and fertility resulting in a reduction in milk output of up to 650 kg/ lactation. Production effects are further compounded by the fact that incidences of SCK in herds may be as high as 40 % and that cows that contract ketosis are at a greater risk of contracting it again in subsequent lactations.

Management programmes should be set up to minimise the risk of transition cow disorders occurring. The following points should be considered:

1) All incidences of transition cow disorders should be recorded and benchmarked against industry standards (Section 3.1.4)
2) A monitoring programme should be set up to identify potential problem cases at an early stage (tipping points) and allow them to be dealt with before they develop. Metabolites that are related to these disorders (serum Ca, BHB, NEFA) can be measured through taking blood or milk samples, depending on the test. It was suggested that at least 12 cows out of every 100 cows that are approaching calving or have just calved should be tested although the accuracy of the interpretation would increase if 30 cows could be sampled
3) Particular attention should be given to putting measures in place that help to reduce the reduction in feed intake that cows experience as they approach calving. Ensuring that cows have adequate feeding space (> 75 cm per cow) is considered to be an essential component of this
4) Ensure that diets fed to transition cows at the various stages of the dry period meet their nutrient requirements
5) Give some thought as to how feed intake can be maximised among cows in the post calving period. For example, changes in feed space per cow (> 60 cm per cow) and the timing and frequency of feed delivery have all been shown to affect feed intake of early lactation cows.

An alternative approach to transition cow management is being investigated at Wageningen UR, where the effects of reducing or omitting the dry period on dairy cow performance are being evaluated. Results to date have shown that milk yield is reduced and that energy balance and fertility is improved by reducing or omitting the dry period particularly among first lactation heifers, but that the response is not as pronounced in subsequent lactations. However the effects noted were variable on an individual cow basis and the colostrum produced from these animals had a lower Ig concentration than that produced from cows that went through a standard dry period. While calves fed this colostrum were found to have satisfactory growth rates, no information was yet available to confirm whether calves fed this material could reach a target LWG of 1.0 kg/ calf/ day in the birth – weaning period, which is being suggested as an additional way of enhancing lifetime performance.

Reducing or omitting the dry period as a means of managing transition cows merits some attention given the positive effects observed with changes in energy balance and fertility and perhaps this approach could also reduce the need for dry cow therapy and antibiotics. However milk output is reduced and responses among individual cows appear to vary. Therefore further investigations into this approach are required before any firm recommendations could be made

7.1.2 Impact of heifer rearing

Heifer rearing is often a forgotten enterprise on many dairy farms. However it was quite clear from speaking to Mike Van Amburgh and discussing the matter with the Loweith family at Summitholm Holsteins and Holterman family at Rosy-Lane Holsteins that the management strategy adopted with rearing heifer replacements will have a major impact on lifetime performance. For example, discussions with Mike Van Amburgh and the Loweith family confirmed that reductions in age at first calving (AFC) will result in an improvement in lifetime yield, confirming observations made by staff at CAFRE that a change in AFC by one month will alter lifetime yield by 600 l/ cow. Work by Boulton (2015) suggested that the average AFC for dairy herds in the UK is around 26 months. This would suggest that there is scope for improving lifetime performance on many dairy farms by reducing AFC to 24 months, which could have a potential benefit of 1,200l/ cow.

A suggested target for AFC for UK dairy farms should continue to be 24 months. It is possible to achieve further increases in lifetime performance by reducing AFC beyond this. While this could be applied to some herds operating a year round calving policy, the seasonal calving pattern of many UK dairy herds would suggest that most herd managers should continue to target an AFC of 24 months for their heifer replacements.

Another aspect of the heifer rearing enterprise that appears to offer significant potential improvements to the lifetime performance of dairy cows applies to the rearing of calves from birth – weaning stage. Work carried out by Mike Van Amburgh and staff at Trouw Nutreco have shown that calves that achieve an accelerated rate of growth (average daily LWG of 1.0 kg/ day) at this stage will develop into cows with an enhanced lifetime yield, which could amount to almost 2,300 l/ cow over 3 lactations.

Targets suggested for rearing calves from birth – weaning were as follows:

1) Double calf’s birth weight by 56 days age

2) Reduce calf mortality < 5 % in the pre weaning phase

3) Maintain calf morbidity treatments < 10 % in this period.

In order to achieve these targets, a number of points must be implemented:

1) Calves must receive a minimum of 10 % bodyweight colostrum at birth and continue to receive colostrum for another four days
2) Calves must be reared in a suitable environment (warm, dry, draught free conditions). Calves reared in unsuitable conditions may use twice as much energy to maintain themselves than calves reared in optimal conditions
3) Maintaining the health status of calves is critical to improving overall lifetime performance
4) Milk replacers need to be fed at a higher rate (900 – 1,000 g/ calf/ day) than traditional milk replacers. The composition of the milk replacer is also altered as the crude protein concentration should be raised to 24 - 28 % CP to encourage growth. Protein quality is also important with the inclusion of amino acids such as lysine, methionine and threonine considered as essential for enhancing growth rate
5) Calves should also be offered increasing quantities of concentrate (25 % CP) from a few days after birth and that the quantity of feed offered should increase as the calf gets older and approaches weaning
6) Weaning should be a gradual rather than an abrupt process carried out at 56 – 63 days of age.

Adopting this strategy will lead to an increase in calf rearing costs. For example, adopting an accelerated growth programme and weaning at 9 weeks age will use approximately 49 kg milk powder and around 45 kg concentrate as opposed to the more traditional approach where around 25 kg milk powder and 45 kg concentrate was used and weaning occurred at 7 weeks age. When these figures were entered into the AHDB heifer rearing calculator (2016), the rearing costs for calves on an accelerated growth programme exceeded those on the traditional programme by around £93 per calf (Table 9). Costings used in the calculations were based on default values in the programme except the value for milk powder in the traditional programme was assumed to be £1,440/ t, while milk powder in the accelerated growth programme was assumed to be £1,600/ t. However if it was assumed that calves on the accelerated growth programme have an AFC which is 2 months earlier than their traditional counterparts, then calves on the accelerated growth programme have a lower total rearing cost. If it was also assumed that heifers reared on the accelerated growth programme produce more milk in their first lactation (at least 700 l/ animal), this would also enhance the economic performance of this approach

Table 9. Estimates of heifer rearing costs on a traditional and accelerated growth programme

Rearing regime	**Traditional programme**	**Accelerated growth programme**
Age at first calving (AFC) (months)	26	24
Costs (birth – weaning) (£/ animal)	380	473
Total rearing cost (£/ animal)	2,160	2,000

7.1.3 Breeding technologies

While the majority of time spent on the study tour examined the effects of breeding technologies focused on cross breeding, opportunities did arise to assess the role that genomics may have to play in extending lifespan so the potential impact of both technologies in altering lifespan will be discussed

7.1.3.1 Impact of cross breeding

Cross breeding would appear to offer some milk producers the opportunity to improve health traits and fertility of their dairy herds and in doing so improve cow longevity, perhaps by 1 – 2 lactations, which appears to be a necessary factor in achieving a lifetime average production of 50,000 l/ cow. There is however some reluctance to adopting this method within the industry, particularly as it may be argued that the use of genomics may achieve similar effects. Part of the reluctance to using cross breeding may be down to breed selection. There is a perception in the local dairy industry that cross breeding dairy cows is restricted to HO x JY crosses. While the benefits of this cross have been clearly demonstrated in spring calving grass based systems in Cork in terms of improving fat + protein yield and cow longevity, the lower milk yields recorded in this system would suggest that using this approach would make it difficult to achieve an average lifetime performance of 50,000 l/ cow without adversely affecting the introduction of new genetics, given the time it would take to reach this target. Indeed results from research carried out at AFBI, Hillsborough would suggest it is also difficult to judge whether the benefits of such a cross would be fully realised on a moderate – high input concentrate feeding system.

Another reason quoted by milk producers for not adopting cross breeding is in the difficulty encountered in deciding what sire to cross an F1 cross with in order to maintain hybrid vigour and the benefits associated with cross breeding. Using the 3 way crossing programme that was demonstrated in Minnesota (HO x MO x VR) may offer more opportunities to milk producers managing moderate – high input concentrate feeding systems to adopt a cross breeding programme as it has been shown that this crossing pattern in higher input feeding systems can result in improvements in longevity and lifetime performance, while maintaining hybrid vigour.

The data in Table 10 attempts to estimate the financial performance of such a cross in local conditions under more moderate concentrate inputs. Figures for HO herds were derived from average results taken from CAFRE benchmarking data, while figures for the cross bred animals were derived from assumptions made through observations on the study tour and discussions which took place among dairy farmers at a number of CAFRE Business Development Groups in recent months. A hybrid vigour effect of 5 % was also assumed. While there was no data available for the performance of cross breds under local conditions it was assumed that the fat + protein yield of these animals would be similar to their HO counterparts. The figures show that while HO may produce a higher milk volume than the cross bred animal, increases in calf value and cull value, plus reductions in replacement rate and veterinary costs show that cross bred animals with a slightly lower milk output than HO can potentially achieve a higher net margin than their HO counterpart. Based on the current data, it would appear that HO would need to increase milk output by approximately 700 - 800 l/ cow to achieve the same level of net profit as its cross bred counterpart. The limitation of this approach however is that the performance figures for cross bred animals are based on assumptions and that there is limited data available to show how such a crossing pattern would perform under UK conditions. Further investigations are required to confirm these observations.

Table 10. Estimated financial performance of Holstein and cross bred cows (£/ cow unless stated otherwise)

	Breed	
	Holstein	Cross breed
Milk yield (l/ cow/ year)	7,280	6,867
BF %	4.01	4.26
Protein %	3.23	3.36
Fat + protein yield (kg)	527	523
Milk price (ppl)	23	23.44
Milk output	1,674	1,610
Calf output	68	163
Replacement rate (%)	29	25
Replacement cost	305	263
Total output	1,438	1,510
Concentrate	461	453
Forage cost	100	100
Vet/ medicine	70	50
Breeding	25	25
Sundries	125	125
Total variable cost	781	753
Gross margin	657	757
Total overhead cost	510	510
Net margin	147	247

While the figures presented may encourage milk producers to consider cross breeding as an option, it is also worth noting that there are additional points that should be considered before adopting a cross breeding programme. They include:

1) Cross breeding will not solve the problems associated with poor management
2) Before embarking on this programme it is important to establish the genetic worth of the existing dairy herd through the analysis of a herd genetic report. In particular, parameters such as fat + protein yield, fertility and udder health and quality (udder depth) should be examined in detail
3) Identify and prioritise which characteristics need to be improved over the next 5 – 10 years
4) High performance sires from the selected breeds should only be used in a cross breeding programme
5) The maintenance of accurate breeding records of which breed sires are used on individuals is essential for the success of the programme

6) Cross breeding may complicate matters by creating animals within the herd that differ in size, which may create issues in relation to milking and housing. However all the farms that I visited had not found this to be a problem
7) As with HO, attention should be paid to transition cow management programmes to ensure that animals calve down at the appropriate body condition score (2.5 – 3.0) and that they are managed to realise their full lactation potential post calving

7.1.3.2 Impact of genomics

Those milk producers who manage a Holstein herd and do not wish to adopt a cross breeding programme should consider the role that using genomics could play within their systems. The use of genomic data can help to speed up the rate of genetic progress within a dairy herd. In addition the genomic testing of female stock can allow the herd manager to identify which animals have the greatest genetic potential for a range of parameters including longevity, so that they can concentrate on rearing and bringing these animals into the milking herd and allow for a more targeted breeding approach of stock in the herd. The range of parameters that can be measured continues to increase with major efforts being made to identify markers for traits such as improved health, better feed efficiency and reductions in greenhouse gas production. It is important to remember while female Holstein stock can be genomically tested, cross bred heifer calves currently cannot.

As with a cross breeding programme, milk producers should develop a management plan to optimise the use of genomics within their own herds. Points which should be considered include:

1) As with cross breeding, establish the genetic worth of the existing herd through creating a herd genetic report
2) Identify and prioritise which characteristics need to be improved over the next 5 – 10 years
3) All female youngstock in the herd should be genotyped
4) Use the best sires available
5) Remember that genomic proofs have lower reliability values than full bull proofs. To minimise the risk and maximise the potential benefits a wider number and range of sires will need to be used than would have been used with sires selected from the traditional bull testing programme

7.1.4 Is a 50,000 l herd average possible?

The question remains as to whether a 50,000 l herd average in the UK is possible through adopting the practices outlined in this report. While extensive research has been carried out in the individual areas outlined on the production of dairy cows, I was unable to find out from anywhere I visited as to what the potential impact on lifetime performance would be of combining these practices, in terms of trial work or the development of a predictive model. However when I did question everyone they felt that the effects of these individual factors would be additive when combined in a milk production system. In the light of this information, I am now going to speculate as to what changes in lifetime performance could be achieved by adopting these factors within the management programme of a dairy herd

A certain number of assumptions have been made which are quoted in Table 11. For example, it was assumed that the average UK herd is similar in terms of production characteristics to that quoted by Hanks and Kossaibati, M. (2017) and Boulton (2015), where average lifetime production was around 27,000 l/ cow and average AFC was 26 months respectively. Using the findings of the study tour it was assumed that the average LWG of calves reared in a pre weaning phase in the average herd was 0.5 kg/ calf/ day and that there was an incidence rate of SCK of 40 % within the herd. It was assumed that adopting the appropriate practices within transition cow management, calf rearing and cross breeding would reduce AFC to 24 months, increase average LWG in the pre weaning phase to 1.0 kg/ calf/ day, reduce incidences of SCK to 0 and increase lifespan of the herd by 1 lactation

Table 11. Projected effects of various management practices on lifetime performance

	Current Average Herd	**Projected Average Herd**
Age at first calving (AFC) (months)	26	24
Pre weaning liveweight gain (kg/ calf/ day)	0.5	1.0
Incidence rate of sub clinical ketosis (SCK) (%)	40	0
Age by lactations	3.6	4.6
Age by exit (Years)	6.0	7.0
Projected lifetime performance (l)	26,937	39,063

Adopting the practices outlined was assumed to have the following effects on lifetime performance

- Reducing AFC from 26 to 24 months = 2 months x 600 l/ month = 1,200 l/ cow
- Enhancing calf growth in pre weaning phase = 1,500 l/ cow
- Reducing ketosis – An incidence of SCK was assumed to reduce milk output by 650 l/ lactation. Assuming 40 % cows are affected, then average yield reduction is 260 l/ lactation, which when spread over 3.6 lactations = 936 l/ cow

If this occurred over 3.6 lactations the resultant lifetime performance would be 30,573 l/ cow (14.0 l/ cow/ day or 8,492 l/ lactation). However it was assumed that the cross breeding programme will extend the lifespan of the herd by 1 lactation. Therefore the resultant lifetime performance of the herd could be 39,063 l/ cow (15.2 l/ cow/ day). Such levels of lifetime performance are already being achieved in herds such as the CAFRE Future herd where attention has been focused on optimising transition cow management and heifer rearing practices.

While the figure is still less than the target of 50,000 l/ cow, it is interesting to note that if the same practices were applied to the top 25 % of herds analysed by Hanks and Kossaibati (2017), the resultant lifetime performance could be 48,094 l/ cow (17.1 l/ cow/ day) achieved over 5 lactations or 7.7 years, which is quite similar to the figures highlighted earlier in the discussion for Scenario A in Table 8.

The limitation with this approach is that while the effects of transition cow management, calf rearing and cross breeding may be additive in the management of a dairy herd, it is possible that the combined effects may not be manifested to the degree quoted in this report. For example, the benefits of an accelerated growth programme for rearing calves are likely to overlap with the positive benefits associated with reducing AFC to 24 months age. It is also important to remember that factors such as average lactation yield should change as the herd gets older and this will also have an effect on the projected figures. However what this exercise does highlight is that it is possible theoretically to achieve a 50,000 l herd average through the adoption of a range of best management practices. It also highlights the need for a research programme to be carried out which will identify the impact of best management practices on lifetime performance, which in turn could lead to the development of a predictive model that could be used within the industry. The development of such a programme could encourage the uptake of the technologies outlined and other practices by milk producers, which would benefit the lifetime performance of dairy cows and in doing help the dairy industry to reduce costs, reduce the impact of the dairy industry on the environment and increase the marketing value of dairy produce.

8.1 Conclusions and Recommendations

1) Achieving a lifetime average yield of 50,000 l/ cow in dairy herds in the United Kingdom may be possible over the medium – long term
2) Changes in breeding, dairy herd fertility and mastitis management appear to be the main drivers to date in improving lifetime performance
3) Transition cow management has a significant part to play in improving milk output. Sub clinical ketosis in particular is likely having an impact on herd production in the United Kingdom. Herd owners should now be setting up a programme to monitor the risk of animals developing this disorder and take measures to prevent it occurring
4) Attention should also be paid to the management programme adopted with rearing calves in the birth – weaning stage. Calves at this stage should be managed to achieve a LWG of 1.0 kg/ calf/ day to improve lifetime production
5) Replacement heifers managed with a seasonal calving pattern should be reared to achieve an average age at first calving of 24 months age
6) The issue of cross breeding needs to be discussed more extensively within the industry. Three way crosses involving Holstein, Monbeliarde and Viking Red genetics may produce offspring that will have extended lifespans and operate within a moderate – high concentrate input feeding system. However this technology needs to be examined further under conditions experienced in the United Kingdom. An increased effort should also be made to analyse the performance of milk producers using cross breeding in their herds
7) Genomics may also be used as a breeding technology to improve lifetime performance and milk producers not involved in cross breeding should evaluate the use of this technology instead within their own herds
8) There is also a need to carry out a programme of research aimed at developing a predictive model to outline the impact of best management practice on the lifetime performance of dairy cows for the benefit of the wider dairy industry

9.1 References

Agriculture and Horticulture Development Board (AHDB) (2016). Heifer rearing cost calculator. https://dairy.ahdb.org.uk/resources-library/technical-information/business-management/heifer-rearing-calculator-cd/#.WoSdpNSLTGg

Boulton, A. (2015) Heifer rearing - worth the investment. https://dairy.ahdb.org.uk/news/dairyleader-articles/march-2015/heifer-rearing-%E2%80%93-worth-the-investment#.WHt2INSLTGg

Faber, S.N., Faber, N.E., Mccauley, T.C. and Ax, R.L. (2005). Case Study. Effects of Colostrum Ingestion on Lactation Performance. *The Professional Animal Scientist*, **21**: 420 - 425

Hanks, J and Kossaibati, M. (2017). Key Performance Indicators for the UK national dairy herd. A study of herd performance in 500 Holstein/Friesian herds for the year ending 31 st August 2017. https://www.nmr.co.uk/uploads/files/files/NMR500Herds-Report2017.pdf

Hazel, A.R, Heins, B.J. and Hansen, L.B. (2017a). Production and calving traits of Montbeliarde x Holstein and Viking Red x Holstein cows compared with pure Holstein cows during first lactation in 8 commercial herds. *Journal of Dairy Science,* **100**: 4139 – 4149

Hazel, A.R, Heins, B.J. and Hansen, L.B. (2017b). Fertility, survival and conformation of Montbeliarde x Holstein and Viking Red x Holstein cows compared with pure Holstein cows during first lactation in 8 commercial herds. *Journal of Dairy Science,* **100**: 9447 – 9458.

Heins, B.J., Hansen, L.B. and DeVries, A (2012). Survivial, lifetime production and profitability of Nomande x Holstein, Montbeliarde x Holstein and scandanavian Red x Holstein crossbreds versus pure Holsteins. *Journal of Dairy Science*: **95**: 1011 - 1021

LeBlanc, S. (2017). The transition period and metabolic diseases in relation to fertility. International Dairy Cow Nutrition Symposium 2017: New Perspectives on Transition Cow Management, https://www.wur.nl/upload_mm/8/2/0/cff4aed6-19ad-484e-989c-804d1e107244_steven%20leblanc.pdf

Prendeville, R., Shalloo, L., Pierce,K.M. and Buckley, F. (2011). Comparative performance and economic appraisal of Holstein-Friesian, Jersey and Jersey x Holstein-Friesian cows under seasonal pasture-based management. *Irish Journal of Agricultural and Food Research*, **50**: 123 - 140

Scheffer, M. (2017). Critical transitions in physiology and ecology. International Dairy Cow Nutrition Symposium 2017: New Perspectives on Transition Cow Management, https://www.wur.nl/upload_mm/1/c/4/a6b1b947-b8d9-4869-9553-6124207c7ca6_marten%20Scheffer.pdf

van Knegsnel, A.T.M. (2015). Customising dry period length to improve adaptation to lactation. International Dairy Cow Nutrition Symposium 2015: Dairy Cow Nutrition and Animal Health, www.wur.nl/upload_mm/8/c/9/37aa70c3-760c-4153-9d16-bf8ed385b384_1_vanKnegsel.pdf

Whitaker, D.A., Macrae, A.I. and Burrough, E. (2004). Disposal and disease rates in British dairy herds between April 1998 and March 2002. *The Veterinary Record*, **155**: 43 - 47