Abbreviations used in this issue
BCS = body condition score
BHB = β-hydroxybutyrate
DCT = dry cow therapy
NEB = negative energy balance
NEFA = non-esterified fatty acids
RCT = randomised controlled trial
SCC = somatic cell count
TMR = total mixed ration

Welcome to the latest issue of Dairy Research Review.

This issue features three mastitis-themed research papers. The mediators of inflammation during mastitis and mechanisms underlying impaired lactation are reviewed, the effects of selective DCT at the quarter level are assessed, and the practicalities and economics of on-farm clinical mastitis prediction systems are evaluated.

Other selections cover keeping pre-weaned calves warm to increase gain, the economics of fixed-time artificial insemination, how diet can affect animal nitrogen excretion patterns, and selective breeding to reduce greenhouse gases.

We hope that you enjoy this issue of **Dairy Research Review**. We value your feedback so please keep sending us your comments and suggestions.

Kind regards
Hamish Newton
hamishnewton@animalhealthreview.co.nz

Research Review thanks AgriHealth for their sponsorship of this publication, and their support for ongoing education for animal health professionals.

Temporal profiles describing markers of inflammation and metabolism during the transition period of pasture-based, seasonal-calving dairy cows
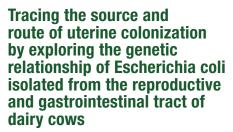
Authors: Spaans OK et al.

Summary: The transition from pregnancy to lactation in dairy cows is physiologically complex. These researchers present a compilation from 20 experiments spanning almost 20 years, representing a comprehensive research data set for temporal profiles of blood analytes for pasture-fed transition dairy cows in NZ. The data set provides a valuable knowledge base for various biomarkers of relevance to transition cows in pasture-fed, seasonal-calving dairy systems. The researchers discuss important temporal trends and range in values reported for energy, protein, mineral, liver function, inflammation, and uterine and other health variables in NZ dairy cows.

Comment: This paper collates the results of blood results from 20 DairyNZ projects. The patterns of change in the metabolites were what we expect, reflecting "a peripartum uncoupling of the somatotropic axis in anticipation of the energetic demands of lactogenesis and an associated increase in hepatic gluconeogenesis". I will concentrate on the markers of energy balance here, as that is what interests me most at present. The concentration of NEFAs and BHB peaked between 7- and 14-days post calving which for those of you who have done calculus is consistent with the maximum rate of BCS loss reported by Roche et al. (2007) from the first derivative of the BCS profile in pasture-based cows. The actual BHB values are higher than cows on a TMR doing similar production with similar NEFA levels so remember not all of the hyperketonaemia is metabolically induced. The relatively low level of non-fibre carbohydrates in pasture limits the amount of propionate produced that can feed into the tricarboxylic acid cycle; hence, BHB levels are expected to be higher than a TMR-fed cow. This suggests to me that, if looking for NEB in colostrum cows being fed high levels of concentrates, the BHB levels we are used to interpreting may need to alter or be looked at in conjunction with NEFA levels.

Reference: J Dairy Sci. 2022;105(3):2669–2698
Abstract

Tracing the source and route of uterine colonization by exploring the genetic relationship of Escherichia coli isolated from the reproductive and gastrointestinal tract of dairy cows

Authors: Jones K et al.

Summary: This study investigated the source and route of bacterial colonisation of the uterus by exploring the genetic relationship among *Escherichia coli* strains isolated from the gastrointestinal (GI) and the reproductive tract of 34 dairy cows pre- and postpartum. Uterine health status (metritis vs healthy) was also evaluated. The results suggest that the GI tract is the likely source of bacteria that colonise the reproductive tract via ascending colonisation of the uterus by way of the lower genital tract. In addition, cow-to-cow transmission occurs and strains are not specific to body site or health status.

Comment: This study looked at where the E. coli that colonises the uterus post calving comes from and tries to explain how it gets there. On balance this paper supports the idea that it is due to an ascending colonisation from the GI tract via the reproductive tract, but it does not rule out the possibility that the spread from the GI tract is via the blood to the uterus and the colonisation of the vagina is by descending colonisation. No real surprises here and if we look over our shoulder at our equine colleagues, we see them performing caslicks routinely to prevent ascending infections (I am not suggesting cows and horses are the same though). The interesting part of this paper was as methods of detecting colonisation of the uterus have progressed from culture to "culture independent techniques" the prevalence of gram-negative anaerobes, which are fastidious to culture, compared to the gram-negative aerobes (e.g. E. coli) has increased. Nevertheless, E. coli is well understood and described genetically and some of its virulence factor genes are associated with metritis. It may be that, with different techniques to detect what is present in infectious conditions, other bugs may be more important than what we currently think.

Reference: Vet Microbiol. 2022;266:109355
Abstract

The effect of environmental temperature on average daily gain in preweaned calves: A randomized controlled trial and Bayesian analysis

Authors: Hyde RM et al.

Summary: Previous research suggests that lower environmental temperatures are associated with lower average daily gain (ADG) during the preweaning phase in neonatal calves. This RCT demonstrated that 1-kW heat lamps had a significant positive impact on the ADG of preweaning calves on dairy farms during colder periods. Calf jackets, however, were not significantly associated with ADG. The results also suggested that environmental temperature was positively associated with ADG in calves during colder periods, which was reinforced when data from previous research was integrated through a Bayesian analysis.

Comment: A total of 79 calves from one farm were housed individually in pens with or without a heat lamp and were put in a calf jacket or not. The four pens with a heat lamp had a 1KW heat lamp suspended 1m above the bedding and shared the lamp so that the calves got the similar number of Watts as what we get from a "standard" heat lamp used for rearing orphan lambs. Calves were weighed at birth and again between 14 and 33 days of age (mean 19 days) later. The average temperature in the unheated pens was 7.11°C (range: −1.59°C to 19.20°C) compared with the heated pens 11.98°C (range: 3.67°C to 25.16°C). There was minimal difference (0.4°C) between the ambient shed temperature and the outside temperature. Calves under heat lamps grew 90g a day faster than those not under a heat lamp. There was also an association between mean environmental temperature and calf growth rate with an increase in ADG of 0.03 kg/day for each 1°C increase in building temperature. The wearing of calf jackets was not associated with ADG. This seems counterintuitive to me but the lack of a growth response to wearing jackets is consistent with previous publications referenced in this paper. This paper suggests warmer sheds result in calves growing faster and that jackets do not help. Whether or not jackets make a difference once calves are out of the shed this paper cannot answer. Before drawing too many conclusions from this paper it is worthwhile remembering these calves had limited room to move (generate heat) and were in individual pens so could not huddle together. The idea of a heat lamp suspended 1m above a group of calves personally frightens me with visions of fire and calves pilling up in a messy heap under a heat lamp. Jackets outside might mitigate the effects of windchill and wetness, but this paper does not support their use while inside.

Reference: J Dairy Sci. 2022;105(4):3430–3439
Abstract

Independent Commentary by Hamish Newton

Hamish Newton graduated from Massey University with a BVSc in 1998 and started working in mixed practice at the Veterinary Centre – Oamaru. He then worked in mixed practice in the UK before starting a PhD at Bristol University examining factors that influence the cure of intramammary infections in the involuting mammary gland. Upon completing his PhD in 2007 he returned to the Veterinary Centre – Oamaru and became a partner in 2008. He now spends most of his working time dealing with dairy cows.

Using Dairy Research Review for CPD points

Reading relevant veterinary articles such as those in Dairy Research Review is a valuable way to keep current and can become part of your CPD record. Simply record the activity on your activity record and create a reflective record by writing a few sentences about what you learnt and how this impacts your practice as a veterinarian.

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https://www.vetcouncil.org.nz/Web/Veterinarians/Continuing_Professional_Development.aspx

Bacteriological outcomes following random allocation to quarter-level selection based on California Mastitis Test score or cow-level allocation based on somatic cell count for dry cow therapy

Authors: McDougall S et al.

Summary: These researchers assessed the effect of selecting and treating cows at quarter-level with DCT based on the California Mastitis Test (CMT) compared with selecting and treating cows for DCT based on the maximum SCC across lactation. Selection at quarter-level based on the CMT resulted in more quarters being infused with DCT compared with selecting cows based on a SCC. Selection based on the CMT resulted in a higher bacteriological cure proportion, a lower new intramammary infection (IMI) proportion over the dry period, a lower prevalence of IMI post calving, and a lower proportion of cows with a SCC >200,000 cells/mL at first production recording in the subsequent lactation, but there was no difference in the incidence of clinical mastitis over the dry period or the first 30 days of subsequent lactation. However, overall antimicrobial usage was higher in the cows for which treatment was based on the CMT score compared with cows selected based on a SCC.

Comment: We are all aware of the need to reduce antibiotic use and we are achieving this relatively easily by switching to selective DCT at the cow level. This paper looks at whether antibiotic usage would be further reduced by using selective DCT not at the cow level, but at the quarter level based on CMT results at the time of dry off. Another reason to consider this approach is that in the 2016–17 season only 64.3% of NZ herds were herd testing. Cows were assigned to one of two groups. The SCC group got all four quarters treated the same, the quarters either got an Internal Teat Sealant (ITS) alone or an ITS and DCT based on whether the cow had a herd test result >200,000 cells/mL. The cows assigned to the CMT groups were paddle tested at dry off and if there was a trace reaction the quarter got DCT and ITS, if the quarter did not react to the CMT it got ITS alone. There was no difference the amount of clinical mastitis in the first 30 days post calving between the groups, which to me is the most important clinical outcome, but there were differences in the bacterial cure rate, new IMI rate, prevalence of an infection at calving, which were all favourable for the CMT group. The trouble is that the cows in the CMT group received a greater amount of antibiotics (63% more by mass). This result is explained by the very high sensitivity of the CMT when a "trace result" resulted in DCT use. The sensitivity was 96% but this resulted in a positive predictive value of only 3.4%, so 94% of CMT-positive quarters were actually not infected with a major pathogen. For comparison, the sensitivity of using a 200,000 cells/mL cut point was 75%. If a farmer wants to implement selective DCT by selecting cows based on a paddle test there will be less DCT used compared to blanket DCT but they will use more DCT than if they had herd tested. So, if prescribing or trying to estimate how much DCT they might require, think of a "similar" farm that herd tests and expect to need >50% more DCT. If you are questioning the long-term effects of selective DCT then get a copy of this paper and read the discussion, but to summarise very briefly there is likely to be a trade-off between reduced DCT usage and an increased risk of subclinical mastitis and clinical mastitis, but selective DCT is still likely to result in the optimal economic outcome.

Communication skills training and assessment of food animal production medicine veterinarians: a component of a voluntary Johne's disease control program

Authors: MacDonald-Phillips KA et al.

Summary: This study used a pre- and post-intervention design to evaluate how a communication skills training workshop (to support the Atlantic Johne's Disease Initiative in the US) improved the communication skills of practicing food animal production medicine (FAPM) veterinarians. Prior to training, communication skills of participants had limitations, including deficits in skills that have been strongly associated with adherence to veterinary recommendations. The communication skills of the participants were improved following the training workshop.

Comment: This paper examined a formalised communication training course for Veterinarians participating in a Johne's control programme in Canada. Participants were self-selecting so there may be some bias, with participants recognising or perceiving they had a weakness in communication, but it is likely that half of us have communication skills that are "less than average". It seems that it is only when it comes to driving, we all think we are "better than average". Post training, the participants rated their communication skills higher, which is always tempting to do after going to course. This improvement seemed to be supported by the assessments of the "expert raters" though. The training in this course was based on six domains: (1) initiating the session, (2) gathering information, (3) providing structure, (4) building the relationship, (5) explaining and planning, and (6) closing the session. These domains may provide a way to think about your consults. "Skilled communication is a requisite to the practice of effective and compassionate veterinary medicine (Adams and Kurtz, 2017). It is considered a core clinical competency by the American Veterinary Medical Association Council on Education (American Veterinary Medical Association, 2020) as well as the Association of Veterinary Medical Colleges (Association of American Veterinary Medical Colleges, 2018) and the World Organization for Animal Health (World Organization for Animal Health, 2012)."

Economics of timed artificial insemination with unsorted or sexed semen in a high-producing, pasture-based dairy production system

Authors: Walsh DP et al.

Summary: This study evaluated the economics of fixed-time artificial insemination (FTAI) with unsorted and sexed semen (SS) in heifers alone and both heifers and cows in comparison with conventional unsorted semen (CONV) under a high herd fertility state in a seasonal, pasture-based, high-producing dairy production system. The results demonstrated that the annual profit advantage was greatest when FTAI was used in heifers and cows in conjunction with SS. FTAI increased conception rates early in the breeding period helping to consolidate the calving pattern and, when combined with SS, partially offset a lower pregnant-from-a-single-AI-event (P/AI) rate associated with sorted semen. In the FTAI with SS scenarios, the profit advantage was especially augmented by increased genetic gain and higher calf sales revenues. The economic implications of semen type when adopting a FTAI protocol were primarily dependent on the P/AI rate of FTAI and the P/AI rate achieved with SS relative to CONV.

Comment: This Irish paper modelled the economics of FTAI after a synchro programme with either SS, or CONV in either heifers (H) or cows and heifers (HC), compared with a normal mating programme (insemination after a detected heat). A P4-Ovsynch programme with the addition of a prostaglandin shot at day 8 was used /modelled to allow FTAI for the first service of the breeding season. The model assumed that for the normal mating programme there was a 95% oestrus detection rate and a 55% P/AI rate, so a well performing herd. On average all the FTAI protocols were profitable with profit increasing if SS was used over CONV and profit increasing if all cows were FTAI rather than just the heifers. The "downside" is that variation in predicted profit increased with SS over CONV and even more so when going from just doing FTAI on heifers to using it on all cows. In one scenario where the cost for hormones was held at €51/head the average profit over a "normal" mating scenario (and chance of not returning a positive profit) was €1.41 (38%), €11.39 (5%), €23.68 (20%), and €30.77 (23%) for FTAI heifers with CONV, FTAI heifers with SS, FTAI all cows with CONV, and FTAI all cows with SS, respectively. The change in profit was most sensitive to the relative conception rates of FTAI versus "normal" heats and the relative conception rate of SS versus CONV semen. This paper does not help us understand the economics of doing just anoestrus or late calvers.

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Graduate Student Literature Review: Systemic mediators of inflammation during mastitis and the search for mechanisms underlying impaired lactation

Authors: Shangraw EM et al.

Summary: In this review article, the authors discuss how the dairy industry's understanding of the regulation of lactation during mastitis has evolved over the past century, with technological advancements in a range of relevant areas from clinical observations to biochemical analyses to transcriptomics. Despite these developments, the factor(s) causing transient hypogalactia in non-inflamed mammary quarters neighbouring mammary glands with clinical mastitis remain elusive. The authors speculate that focusing on systemic factors may reveal the causative mechanisms regulating lactation during clinical mastitis and other episodes of acute inflammation.

Comment: This review looks at what is known about why milk production is reduced in clinically unaffected quarters from cows with mastitis. The summary is, that despite looking, we do not really know. The interesting part is the way that over time the techniques used to investigate this has changed. It started with observational studies to biochemical analysis to now analysis of the transcriptome (the mRNA being expressed). What can happen now is that it is possible to look at the mammary epithelial cell's transcriptome in the milk fat rather than taking biopsies. This technique potentially could help answer a whole range of questions. The decline in milk production of glands adjacent to one with clinical mastitis suggests that other systemic sources of inflammation (endometritis lameness, etc) could also affect mammary gene expression. The reduction in days in milk is likely to only be part of the reason for a decline in milk production.

Reference: J Dairy Sci. 2022;105(3):2718–2727
Abstract

Practical challenges and potential approaches to predicting low-incidence diseases on farm using individual cow data: a clinical mastitis example

Authors: Liebe DM et al.

Summary: Using data collected from two dairy farms, these researchers demonstrate some of the challenges associated with the implementation of clinical mastitis prediction models on a farm. Erroneous data, missing data, sparse cases for training, and varying costs for false positive (FP) and false negative (FN) predictions all affect the efficacy of models in a workflow involving model and farmer insights. Because the number of predicted and actual true- and false-positive cases can be derived using only the model sensitivity (Se), model specificity (Sp), and disease incidence rate, this study helps to inform the relationship between these three variables in practice. Based on the cost matrix used, relatively simple calculations show the models' ineffectiveness with even the best Se and Sp values, in the context of a low incidence rate. Current on-farm clinical mastitis prediction systems will likely require farmer involvement to produce economical results.

Comment: The temptation is to think of mastitis as a common condition, and it is, but if you are an "automatic mastitis detector" looking at every cow every milking then mastitis becomes a reasonably rare event. The example in this paper describes the typical US dairy farm with between 25 and 40 cases of mastitis per 100 cows per lactation. This equates to roughly one clinical mastitis case per 890 to 1460 days per cow (0.07% to 0.1%). In my experience, the farmers who have installed inline mastitis detectors have got sick of them quickly due to the high number of FP alerts. This makes sense when the incidence rate is expressed as case per x cow days as above. This paper used milk data as well as data from the cows' wearable technology to create models that looked at the rate of change in yield, milk components, lying times, etc over the days prior to a recorded mastitis event. Different models were constructed for both Gram negative (GN) and Gram positive (GP) mastitis cases due to the slower/longer duration of changes for GP mastitis and less dramatic reduction in milk yield. The most important variables in the model for detecting GP mastitis were lactose and protein changes. Costs were then attributed to the FP and FN results for different Se and Sp thresholds. The model that was economically optimal for detecting GP mastitis cases had a Se of 37.5%, Sp of 99.9%, and a positive predictive value of 53%. This differs markedly from models that meet International Organization for Standardization guidelines (Se of 80% and Sp of 99%). While the models developed here perhaps are not applicable yet, (I cannot think of an inline system measuring lactose and protein) it does make you think about tests and how they perform when the prevalence of disease is low and there are costs associated with FPs and FNs and of the issues with "alarm fatigue" (too many cows to screen each morning).

Reference: J Dairy Sci. 2022;105(3):2369–2379
Abstract

Urine and fecal excretion patterns of dairy cows divergent for milk urea nitrogen breeding values consuming either a plantain or ryegrass diet

Authors: Marshall CJ et al.

Summary: The objective of this study was to evaluate and report diurnal fluctuations in excretion patterns for both faecal and urination events of cows divergent for milk urea nitrogen breeding values (MUNBV) that were fed either rye grass (RG) or plantain (PL). The results showed that low MUNBV cows will have a reduced environmental impact relative to high MUNBV cows consuming RG. Lower levels of urinary urea nitrogen (UUN) and higher levels of nitrogen (N) in faeces were also observed for cows consuming PL compared with those consuming RG, indicating likely reductions in environmental impact when using a PL diet. The differences based on MUNBV in the excretion patterns of urine and faeces, and thus nutrients, support the concept that these cows have different characteristics of ingestion and digestion, and hence absorption and excretion of nutrients.

Comment: A dairy cow's utilisation of N is usually <30%, so approximately 70% of ingested N is not used for production and approximately 60% of the unutilised N is excreted via the urine. About 20% to 30% of urinary N gets leached to ground water as nitrates, 2% as the greenhouse gas N_2O. This was a study that looked at cows that had high or low breeding values (BVs) for milk urea nitrogen (MUN) that were fed either RG or PL. The cows' faecal and urine output was collected and measured. Firstly, I think it important to state that the cows were fed ad lib either RG or PL, not a mix like we are starting to see in some paddocks. The PL diet had more reproductive and dead material in it than the RG diet. The PL diet was also lower in dry matter, crude protein, neutral detergent fibre, acid detergent fibre, and megajoules of metabolisable energy per Kg of dry matter. PL had higher water-soluble carbohydrates than RG. The effect of the MUNBV variable was most marked when the cows were fed RG. This is at least partly explained by cows with a BV for low MUN doing more "oral processing". This results in smaller particle sizes and presumably quicker transit time through the rumen (less time for NH_3 production), more salivation, and greater release of water-soluble cell contents from the RG diet than the high MUNBV cows. The level of UUN was lower in the cows fed PL regardless of their MUNBV. When fed RG the UUN level was highest in the high MUN cows. The reason for the lower UUN level in the PL fed cows could be due to the lower CP, higher water-soluble carbohydrate level (more efficient utilisation of N by rumen microbes) or that PL is more easily masticated so a faster rumen transit time. PL also contains "plant secondary compounds", which have antimicrobial and diuretic effects, and these are likely to part of the reason as for lower UUN as well. Differences were found in the urination volume per event (pee). There were more urination events if a cow was fed PL regardless of MUNBV. Taken at face value, cows fed PL, or cows with a low MUNBV fed RG have a lower level of UUN. This results in a greater proportion of excreted N getting into the faeces, which the "environment" can deal with better (less lost to ground water). A greater number of urination events are also less likely to overload the "environments" ability to stop N being lost to the ground water. I do not know enough about the agronomy of PL to know how it will fit into our systems as a pure sward (persistence, grazing intervals, etc) or with pasture mixes it is in, whether it has any of the effects reported here. There is no mention in the paper of how much PL or RG the cows voluntarily ate, or any idea of what production may be like on PL alone. I found it most interesting that there is the ability to select for low MUN cows and the mechanism by which they have low MUN may be due to how they actually "orally process" their food.

Reducing greenhouse gas emissions through genetic selection in the Australian dairy industry

Authors: Richardson CM et al.

Summary: According to the results of this study, a greenhouse gas (GHG) subindex tool that dairy farmers can use for industry application will, at least in the short term, be effective in reducing gross emissions while maintaining profits. The implementation of a GHG subindex in the Australian dairy cow breeding programme can achieve up to a 7.9% decrease in residual methane and nine times the reduction in GHG gross emissions within 10 years compared with the current breeding programme, without substantial cost to farmers.

Comment: This paper looked at the predicted effects of different selection indexes at four different carbon prices on reducing greenhouse gas emissions. In Australia, the most widely used selection index is the Balanced Performance Index. Interestingly, there is also an index called the Health Weighted Index (HWI), which gives traits a "noneconomic value-based farmer preference for improvements" to reflect the interests of farmers separate from economics and profit. The three indexes examined were developed by varying the Green House Gas subindex (GHGindex) within the Balanced Performance Index (includes the traits for protein, fat, milk, survival, and feed saved). The first was leaving the GHGindex as it currently is, the second was to add in a low accuracy methane trait, and finally the addition of a higher accuracy methane trait that has not been created (a theoretical trait). The authors are unaware of any residual methane estimated breeding value with an accuracy appropriate for industry application being available in the world, so the third option is at present not applicable but if it becomes feasible will result in reductions roughly twice the size of the current indexes. As a traditional breeding index is used to increase profit or efficiency it is no surprise that as the price of carbon increases the reduction in emissions will increase as relatively more weighting swings towards reducing the cost of emissions. The results show that the existing indexes will reduce emissions while maintaining profits and if a more accurate sub-indices are available much bigger gains will be achieved.