Dairy RESEARCH REVIEW™

Making Education Easy

Issue 36 – 2023

In this issue:

Welcome to the latest issue of Dairy Research Review.

This issue features research on whether vitamin B12 supplementation in dairy calves delivers an increase in weight gain, how the neonatal acute phase immune response influences future health and lactation performance of dairy cows, and the effects of grass management technologies on the performance of pasture-based dairy farms. Other research considers the potential for dietary manipulation to reduce methane production in dairy cows and the effect of 3-in-2 milking frequency on milk yield and composition. Also included in this issue are two reviews that respectively discuss the benefits or otherwise of prophylactic claw trimming and how antibiotic resistance can be spread via dairy manure.

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

Kind regards

Hamish Newton

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The effect of parenteral vitamin B12 on the growth rate of dairy calves over the summer and autumn on seven farms from the Central Plateau, New Zealand

Authors: Gibson M et al.

Summary: This controlled clinical study investigated the effect of parenteral vitamin B12 supplementation on the growth rate of dairy heifer calves over the summer and autumn on seven farms in an area of NZ known to be at risk of having low soil cobalt and hence low grazing pasture cobalt levels. Although an effect of treatment group on final weight (p=0.014 for overall analysis) was identified, this finding did not necessarily indicate that vitamin B12 supplementation increased final weight in these calves given that the only statistically significant effect identified in the individual comparisons was a difference in final weight between calves treated with long- versus slow-acting vitamin B12 products.

Comment: This trial conducted on dairy replacements on farms around Taupo looked at weights of calves that got short-acting B12 injections monthly, a long-acting B12 injection three monthly, or no B12 injections. All calves, however, were receiving oral anthelmintics "at a frequency that was less than the recommended dose interval for that product" that contained cobalt. Pasture cobalt levels were measured throughout the study. The majority (78%) of pasture samples had cobalt levels above the recommended minimum of 0.06 mg/kg dry matter. The final weights were 228kg for the long-acting B12 group, 226kg for the no injection group, and 224kg for the short-acting B12 group. As all calves were run together extra yarding for the short-acting B12 group does not explain these results unless the "stress" of injections is more profound than I perceive? This paper has made me pause for thought about whether routine B12 injection are necessary for dairy replacement calves. Time for some more pasture sampling perhaps?

Reference: N Z Vet J. 2023 Sep 7 [Online ahead of print]

Abstract

Associations of neonatal acute phase response with first lactation performance in dairy cows

Authors: Loch M et al.

Summary: The aim of this study was to use acute phase proteins and proinflammatory cytokines as biomarkers for describing processes during the first three weeks of life that have a relationship with future performance and health, specifically during the first lactation period, by investigating associations of neonatal acute phase response (APR) with future lactation performance. In a sample of 117 cows from a single farm, haptoglobin (Hp), serum amyloid A (SAA), interleukin-6 (IL-6), and tumour necrosis factor-alpha (TNF-α) were valid indicators of events and processes during the neonatal period influencing the future health and lactation performance of dairy cows. These biomarkers could be used as tools in future research into different calf management practices.

Comment: Calves had blood and faeces collected weekly for their first three weeks of life. From the blood analyses, cytokines (IL-6 and TNF-α), SAA, and Hp were independent explanatory variables. There was some "collinearity" between these variables so there were many models created examining reproductive success, milk yield, and average daily weight gain to 12 months of age. The APR (what was measured in the blood) influenced growth rates which, by itself, also influences reproductive success and milk yield. There was also an outbreak of cryptosporidiosis and calves were categorised by how many oocytes were in the faeces and whether they received treatment for cryptosporidiosis and this was accounted for in the models. The magnitude of the effect of the APR on daily weight gain decreased as the calves got older, the coefficient was greater for the daily weight gain at nine months compared to 12 months. What is not clear is if the measures in the blood are pathological or a physiological adaptation (maybe a first immune response of gut colonisation) as once the cryptosporidiosis status of calves was accounted for the associations remained. Of course, we do not know if there were subclinical infections that were not detected, e.g., rotavirus that may have resulted in an APR. Perhaps in the future we might be using acute phase proteins as predictors, but it seems unlikely any time soon.

Reference: J Dairy Sci. 2023;106(9):6353-6364
Abstract

Blood biochemical changes upon subclinical intramammary infection and inflammation in Holstein cattle

Authors: Pegolo S et al.

Summary: These researchers investigated the associations between naturally-occurring subclinical intramammary infection (IMI) due to different pathogens with inflammation status and a range of blood biochemical traits including energy-related metabolites, indicators of liver function, oxidative stress metabolites, inflammation or innate immunity indicators, and mineral status in 349 lactating Holstein cows. The study results indicated the feasibility of using certain blood biochemical traits, mainly acute phase proteins and oxidative stress markers, for the detection of subclinical IMI and inflammation in dairy cattle.

Comment: This study looked at the blood chemistry of Italian cows that had composite milk samples taken from them to examine what effect subclinical mastitis had. The cows in this study were on average 212 days in milk, had a somatic cell count (SCC) of 487,000 cells/mL, and the most common pathogen isolated was *Streptococcus agalactiae*. Unsurprisingly, SCC went up with infection, which is what we all use as a proxy for subclinical mastitis. In this study, 40% of cows with a pathogen isolated from milk had a SCC <200,000 cells/mL and 20% of pathogen-positive cows had a SCC <100,000 cells/mL so looking at other indicators of infection in the blood seems sensible, at least in this population of cows (which hopefully is not representative of what most of us deal with). There were blood markers that were associated with SCC (e.g., glucose), which is interesting but seems unlikely to help us clinically – we already know the SCC. A positive bacterial result was associated with increased haptoglobin, but again haptoglobin also went up with SCC. I think this paper reinforces that herd testing is a good tool (perhaps the best we have) and subclinical mastitis is not confined to the udder but does have systemic effects we can detect in the blood.

Reference: J Dairy Sci. 2023;106(9):6539-6550
Abstract

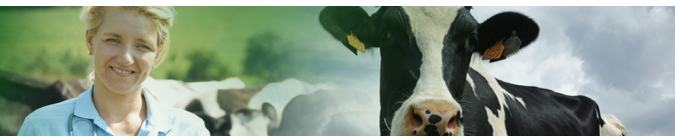
Evaluating the effects of grass management technologies on the physical, environmental, and financial performance of Irish pasture-based dairy farms

Authors: Palma-Molina P et al.

Summary: These investigators analysed farm-level data collected from the 2018 National Farm Survey (NFS), which is a survey conducted annually in Ireland by the agriculture and food development authority, to contribute to empiric research around the effects of grass management technologies on the performance of pasture-based dairy systems. The analysis found that farms utilising grass management technologies generally had better physical, environmental, and financial performance than farms not using such technologies. However, after adjusting for selection bias, the investigators could only attribute a positive causal effect of grass management technologies on the use of grazed pasture per cow, grazing season length, milk yield per cow, and milk solids per cow.

Comment: This study looked at the performance of Irish Dairy farms that used "grass management technologies", which in this paper meant the use of plate meters and/or a decision-support tool called PastureBase Ireland, which is a programme that generates feed wedges and spring rotation planners, etc. Unsurprisingly, farmers that used these tools had on average better performance, but as a reminder of how science works the study could not establish a causal link between many of the factors measured that improved and the use of these technologies due to selection bias. This is because the decision to use technologies is not random, as farmers self-select to adopt technologies, due to multiple factors that may be observable, or not. Factors that influence a decision to adopt technologies may also influence farm performance – resulting in selection bias. It was discussed that farmers that utilise grass management technologies may invest more in fertiliser, grazing infrastructure, grass cultivars, etc. Another possible reason for some causal relationships not being found was that some farmers may not use the technologies to their full potential. This paper served as reminder that what appears to be driving an outcome may not always be the sole factor and investment in technology will not necessarily result in improvement unless it is used to its potential.

Reference: J Dairy Sci. 2023;106(9):6249-6262
Abstract



Enteric and manure emissions from Holstein-Friesian dairy cattle fed grass silage-based or corn silage-based diets

Authors: van Gastelen S et al.

Summary: This short-term randomised controlled study involving 64 Holstein-Friesian cows had two objectives: (i) to evaluate the potential trade-off between enteric and manure methane (CH_4) emissions of dairy cows when replacing a grass silage–based diet for a corn silage–based diet on a dry matter (DM) basis under practical housing and manure storage conditions; and (ii) to evaluate to what extent these effects on CH_4 emissions are accompanied by a synergistic effect on nitrogenous emissions (ammonia [NH_3] and nitrous oxide [N_2O]). The study found that there was no trade-off between CH_4 enteric emission and manure CH_4 emission and that there were synergistic effects for CH_4 and NH_3 and N_2O emissions when grass silage was exchanged for corn silage, which was attributed to a large difference in dietary crude protein (CP) content.

Comment: Two diets were examined, one was 50% grass silage and 50% concentrate (GS), the other diet was 40% corn silage, 10% grass silage, and 50% concentrate (CS). The CS diet had a 135g of CP/kg DM, which resulted in a milk urea nitrogen (MUN) of 5.4 mg/dL so may indicate these cows were deficient for protein, but the GS diet with 172g CP/kg DM, resulted in a MUN of only 9.1 mg/dL. Both these MUN levels are quite a bit lower than what I am used to seeing. I will not comment on the greenhouse gas (GHG) from the fermentation of the manure as it was small compared to enteric CH_4 and "cow associated" NH_3 and N_2O from the urine. CH_4 was about 10% less for the CS diet. Production of NH_3 and N_2O was also lower in the region of 40%. Three reasons were proposed for the reduced GHG from the CS diet. Firstly, starch results in more propionate production at the expense of acetate resulting in less hydrogen (H_2) for methanogenesis. Secondly, the apparent total tract digestibility for fibre was less for the CS diet, meaning less fibre fermentation in the rumen and some starch escaping rumen fermentation so less H_2 for CH_4 production. Thirdly, there was slightly more fat in the CS diet and fat may inhibit the activity of fibrolytic bacteria and the methanogens. Fat may also act as a "hydrogen sink" during biohydrogenation. Finally, the protein content of CS (below requirements) may have affected CH_4 emissions but the literature is variable on the effect of dietary CP on CH_4 production. The reduced "cow associated" NH_3 from the urine are likely explained by the dietary CP. This paper gives us some understanding of how dietary manipulation or rumen modifiers can work to reduce the production of CH_4.

Reference: J Dairy Sci. 2023;106(9):6094-6113
Abstract

Graduate Student Literature Review: The challenge of drying-off high-yielding dairy cows

Authors: Cattaneo L et al.

Summary: These authors provide a comprehensive overview of the dry-off phase in high-yielding dairy cows. They discuss the physiology behind dry-off, the importance of the dry period, the impact of high milk yield at dry-off, and the different drying-off practices that have been proposed to gradually reduce milk yield in late lactation.

Comment: The act of how we dry off cows is, I think, becoming more and more relevant as we steadily transition away from using antibiotics at the end of lactation. While most of our cows are not producing 20–25L of milk at the end of lactation, I feel the principles described in the paper are still relevant. Many of our cows are still producing 15L at the end of lactation, which was a definition of high production given in the conclusion. Additionally, in NZ, Scott McDougall et.al. found that the odds of clinical mastitis in early lactation were greater (odds ratio 4.79) in cows producing more than 15 L/day at the last herd test compared with cows producing less than 10 L/day. In practice there are two ways to reduce milk yield at the end of lactation, reduce the milking frequency or reduce feed supply. The options of using infusions of casein hydrolysate or dopamine agonists (quinagolide or cabergoline) are discussed but seem unlikely to be allowed in NZ. Reduced milking frequency results in less prolactin, which promotes apoptosis of the mammary epithelial cells as does increased pressure in the gland. The potential issue is that the risk of leaking teats increases and that in turn increases the risk of infection. Cow comfort may also be compromised. With the feed reduction, yield is lowered by a decrease in nutrient availability to the mammary gland and reducing mammary glucose uptake. While cows may be more comfortable, they might experience hunger. As we transition away from antibiotic dry cow therapy more thought or discussion about reducing yields to less than 15L seems sensible. How you achieve it will likely vary from farm to farm.

Reference: J Dairy Sci. 2023;106(9):6416-6426
Abstract

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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.

Investigating the effect of prophylactic claw trimming on the interval between calving and first observed elevated locomotion score in pasture-based dairy cows

Authors: Werema CW et al.

Summary: This study evaluated the response to a three-time point hoof trimming regimen on lameness frequency and time from calving to observation of an elevated locomotion score (LS) in a 940-cow pasture-based dairy herd. Cows (n=250) were randomly assigned to the hoof trimming group and the remainder were assigned to the non-trim group. The results suggest that prophylactic hoof trimming had no clinically relevant effect on the frequency of clinical lameness. In addition, hoof trimming was not associated with a clinically relevant reduction in time to first observed LS ≥2.

Comment: The aim of prophylactic claw trimming, as I understand it, is to even out the pressure on the claws – usually to move the pressure from the lateral claw to the medial claw. This is a widespread practice in housed cattle and is generally supported by the literature. The evidence for the benefit of preventative foot trimming in pasture-based cattle is "limited". Cows in this study were trimmed, prior to drying off (May 2018), early lactation (October 2018), and end of lactation (May 2019); thus, first calvers were not in this study. Cows were locomotion scored fortnightly and the time until they were treated for lameness or were noted to have a LS >1 or >2 were the outcomes measured. This paper found "no evidence of a clinically relevant benefit of trimming on time to first observed lameness" (farmer found or LS >2). It is worth noting that this farm had an incidence of lameness of only 4.3% over the course of the study. This may mean the risk factors for lameness that corrective trimming may have mitigated were not present. Perhaps this is reflected in the fact that at the first trim event (May 2018) only 52% of cows in the trim group required a trim. Of some concern though was at the last trim of the trial (May 2019) 42% required no trim, driven by a cow in the trim group being 2.9-times more likely to need a moderate trim or a lesion trimmed in May 2019 versus May 2018. Unfortunately, we do not know about the non-trimmed cows hoof growth over the season so the apparent deterioration in the feet of the trimmed cows may not be due to trimming. This paper doubles the number of published papers looking at trimming of NZ dairy cows feet. It does have limitations (one herd with a low prevalence of lameness) but to me it suggests that if a farmer has money to spend on lameness prevention it might be better spent on addressing other risks for lameness rather than "mismatched toes".

Reference: N Z Vet J. 2023;71(6):295-305
Abstract

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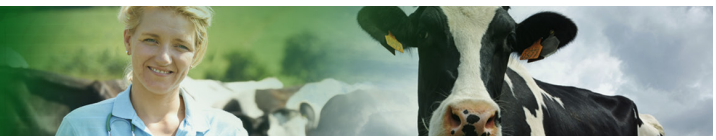

Invited review: Fate of antibiotic residues, antibiotic-resistant bacteria, and antibiotic resistance genes in US dairy manure management systems

Authors: Oliver JP et al.

Summary: The focus of this review article is the presence of antibiotic residues, antibiotic-resistant bacteria (ARB), and antibiotic resistance genes (ARG) in dairy manure and how they can contribute to the dissemination of antibiotic resistance (AR). Specific topics covered include antibiotic resistance in untreated dairy manure, solid-liquid separation, anaerobic digestion, long-term manure storage and lagoons, field treatment systems, and future research needs.

Comment: "Although ARB and their ARG have existed for millennia, their prevalence has rapidly increased in conjunction with widespread manufacturing and anthropogenic use of antibiotics." This paper suggests that the likely route of transferring AR from farm animals is via urine and faeces containing ARB and ARG making their way into "croplands and natural systems, which may then serve as AR reservoirs and vectors to human pathogens". It was suggested this route to spread AR is more likely than contaminated products due to withholds and product surveillance. The paper also mentions land used for the disposal of human waste, like land used to spread dairy manure, has higher levels of ARG. The paper discusses effluent systems that are not very relevant to NZ where we mainly deal with the effluent off the yards and do not do composting or have anaerobic digesters. There is a section on "long-term manure storage and anaerobic lagoons" though most research on these has been on pig farms and "long-term" is not defined but it may well be longer than we store effluent for. Some ARGs seem to increase and others decrease. "Additional research is particularly needed to understand AR in long-term storages." To me, the take-home message is we will not be able to do some magic with the effluent to mitigate the spread of AR in cow manure.

Reference: J Dairy Sci. 2020;103(2):1051-1071
Abstract

Effect of altering milking interval when milking 3 times in 2 days on milk and component yields in pasture-based dairy systems

Authors: Hall LS et al.

Summary: These researchers determined the effect of milking interval within a 3-in-2 milking frequency on milk yield and composition at two stages of lactation and compared them with milking once a day (OAD) and twice a day (TAD). No significant differences in milk yield and composition between 3-in-2 milking intervals during early- or mid-lactation were detected, which suggests that farmers using 3-in-2 milking could choose a shorter milking interval on the day with two milkings. Alternatively, 3-in-2 milking would give them the flexibility to select a milking interval that better meets their daily schedule without compromising milk yield.

Comment: I do not think any of us would find the idea of 3-in-2 milking novel and I assume it is widely used throughout the country for labour reasons. Work last century showed milk secretion was linear up to 16 hours post milking so in theory milking every 16 hours should be fine. One issue though is sticking to 16-hour intervals results in some pretty late milkings. This study looked at three versions of 3-in-2 intervals, 12-18-18-hours, 10-19-19-hours, and 8-20-20-hours, as well as twice a day (10-14-10-14-hour intervals) and once a day (24-24 hours). In early lactation, cows milked 3-in-2 produced 8% less milk than cows milked TAD and 14% more than cows milked OAD and the drops were similar in late lactation. In this trial, the milk, fat, protein, or lactose yields were not significantly affected by a 3-in-2 interval in early or mid-lactation. So, if the reason for going to a 3-in-2 milking regimen is for lifestyle reasons it is flexible enough to allow milkings at "better times".

Reference: J Dairy Sci. 2023;106(11):7737-7749
Abstract

Perspective: Could dairy cow nutrition meaningfully reduce the carbon footprint of milk production?

Authors: Hristov AN

Summary: Addressing the question of whether altering dairy cow nutrition can reduce the carbon footprint of milk production, these authors consider what constitutes the carbon footprint of milk (CFM) and what material reduction looks like. They also assess the potential effect that adopting greenhouse gas (GHG) mitigation strategies related to animal nutrition might have on the CFM.

Comment: This paper is a great wee summary of what might be possible to do to reduce the carbon footprint of milk. We in NZ are in a bit of an odd position as being an "extensive pasture-based dairy production system" probably >80% of our GHG comes from enteric fermentation. It has been estimated that a 30% reduction in enteric methane (CH_4) will result in a 26% reduction in the CFM. Compare this with an intensive system where enteric CH_4 is likely <50% of total GHGs, a similar reduction in enteric fermentation will reduce the CFM by about 13%. There seem to be three ways to reduce enteric CH_4 production. The first two are increasing the forage digestibility (quality) and including more concentrates. An increasing proportion of starch/non-fibre carbohydrate in the total dietary carbohydrates would decrease CH_4 emissions. The third approach is using fermentation modifiers, which will reduce enteric CH_4, as research has identified "chemical inhibitors, electron sinks, lipids, and tannins (specifically, tanniferous forages) as having a sizable and, excluding tannins, consistent mitigation effect on enteric methane". Of concern though is that the "rumen microbiome has a tremendous ability to adapt, over time, to exogenous compounds or microbial cultures"; hence, long-term studies will be needed. Also, some of the additives require constant intake. For example, the CH_4 inhibitor 3-nitrooxypropanol results in a 40% reduction in CH_4 immediately after feeding and this reduces to 20% after 10 hours and is undetectable by the time of the next feeding. A reminder of how complicated the rumen is, is that it seems no one knows where the hydrogen ends up when CH_4 production is inhibited, nor has the energy spared from going into CH_4 production been accounted for – hopefully it goes into production. It seems at present that the best we can do is feed our cows the best grass we can, and if economical, more concentrates.

Reference: J Dairy Sci. 2023;106(11):7336-7340
Abstract