Can a virtual fence restrict dairy cows from fresh pasture?

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Abstract.

Virtual fence (VF) technology has the potential to reduce time and labour required to manage grazing dairy cattle. Pasture-based dairy systems rely on accurate allocation of pasture to meet herd requirements and maintain growth for profitability. Maintaining optimal pasture growth requires cows to graze to set target residuals, leaving relatively low levels of pasture. The ability of a VF to maintain cattle in low levels of pasture availability is unknown. Virtual fencing uses associative learning through the delivery of a paired audio tone (AT) and electrical pulse (EP) via animal mounted devices. The commercial neckbands (Agersens-eShepherd™) used in this study utilise GPS to determine animal location and set a VF boundary. This study evaluated dairy cow response to a VF during intensive grazing and during feed restriction. A 1ha paddock of annual ryegrass was divided into 8 pasture allocations. Ten dairy cows were strip-grazed across ten days with one allocation offered each day, except for days 5 and 10 where cows were offered the previous day's residual. Cow location and number of stimuli were recorded each day. Individual variation was evident in stimuli delivered each day as indicated by the range (Table 1). Some cows would receive only an AT (<14), whereas others would receive greater than 10 EP. On the first day of holding off feed (day 5) there were a significant increase in stimuli delivered compared to day 1 (p=<0.01), indicating increased pressure on the VF to access the fresh pasture allocation. However, this was not evident on the second hold off period (day 10), suggesting that the cows were able to learn the routine. This indicates potential to train cows to be held off fresh pasture using a VF. Preliminary results suggest the restricted resource access (such as space and feed) may impact on a dairy cow's response to VF technology.

Table 1. Strip grazing mean VF audio tone (AT), electrical pulse (EP) and proportion of paired stimuli (EP:AT) delivered per day. Including standard deviation (SD) and range. Day 5 and 10 animals were held off pasture.

Day	AT ± SD (range)	EP ± SD (range)	Proportion of paired stimuli ± SD (range)
1	19 ± 10.9 (39)	2 ± 0.9 (2)	0.13 ± 0.10 (0.34)
2	35 ± 19.5 (56)	4 ± 3.8 (10)	0.11 ± 0.04 (0.14)
3	33 ± 17.7 (52)	6 ± 2.6 (8)	0.11 ± 0.07 (0.19)
4	31 ± 17.2 (56)	6 ± 5.4 (17)	0.17 ± 0.08 (0.21)
5	38 ± 30.5 (102)	9 ± 13.4 (42)	0.14 ± 1.12 (0.37)
6	37 ± 21.2 (60)	7 ± 5.5 (17)	0.15 ± 0.08 (0.28)
7	30 ± 16.5 (42)	6 ± 2.8 (8)	0.13 ± 0.08 (0.23)
8	36 ± 19.6 (56)	7 ± 4.6 (12)	0.18 ± 0.05 (0.15)
9	37 ± 23.9 (70)	8 ± 6.9 (20)	0.13 ± 0.10 (0.26)
10	27 ± 20.2 (71)	6 ± 6.6 (18)	0.16 ± 0.12 (0.33)

Additional keywords: Virtual fence (VF), VF stimuli, Audio tone (AT), Electrical pulse (EP), Pasture

Influence of prepartum dietary cation-anion difference and the decline of calcium at the onset of lactation

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Dairy cows experience a dynamic change in calcium (Ca) metabolism in the days around calving, referred to as the transition period. When cows fail to adapt to the demands of lactation, hypocalcemia ensues. Yet, some decline in Ca may have an important role in a successful adaptation to lactation. Negative dietary cation anion difference (DCAD) diets are used during the prepartum period to improve Ca metabolism. This study aimed to determine how Ca decline at the onset of lactation, in combination with positive or negative DCAD diets, altered Ca metabolism. Thirty-two multiparous Holstein cows were blocked by parity and 305d production in a randomized complete block design. Cows were fed a negative (-120 mEq/kg; -DCAD) or positive (+120 mEq/kg; +DCAD) DCAD diet from 251d of gestation until parturition (n=16/diet). Post-parturition, cows were infused for 24h with intravenous solution of either *i)*10% dextrose or *ii)*Ca gluconate (CaGlc) to maintain blood ionized Ca (iCa) concentration at 1.2 mM (normocalcaemia) creating four treatment groups (n=8/treatment). Blood was collected every six hours for four days +/- calving to monitor iCa concentrations. Groups were compared using a mixed model ANOVA. Feeding a -DCAD diet pre-partum decreased blood pH ($P<0.01$) and increased ($P=0.04$) blood iCa concentrations as compared to cows fed a +DCAD diet. Cows fed a -DCAD diet had greater circulating serotonin concentrations as compared to +DCAD cows ($P=0.0098$). Cows infused with CaGlc had lower iCa concentrations as compared to cows infused with dextrose 12h after termination of infusion ($P<0.01$), with +DCAD/CaGlc cows having the lowest blood iCa at this timepoint (0.88 ± 0.03 mM; $P<0.05$). Collectively, maintaining normocalcaemia by infusing CaGlc during the 24hrs post-partum impaired Ca homeostasis in the immediate postpartum period regardless of dietary treatment. Prepartum -DCAD diets can be useful to improve Ca metabolism and support the transition to lactation.

Keywords: calcium, transition, DCAD

Towards naturalistic rearing environments and individual development: the potential welfare benefits of rearing dairy heifers at pasture with older social models

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Abstract

As most commercial dairy farms separate calves from cows within 24h of calving, heifers rarely interact with older animals until their first lactation. Early life social experiences can, however, affect behavioural development, with long term consequences. This presentation explores the potential for enriched social environments to improve heifer development and welfare. It will present preliminary results from an experiment investigating the effects of rearing dairy heifers with adult dry cows as social models on calves' behavioural responses to social isolation.

Forty dairy heifers were mixed into groups of 10 at 2wk of age, and one of two treatments applied until 13wk: 1. Hand-reared, group-housed calves (-S), or 2. Hand-reared, group-housed calves housed with 3 non-familial dry cows (+S). All groups were housed on pasture and fed 3L whole milk twice/day. At 12wk of age, calf responses to social isolation were tested in an enclosed arena. Following a 5 minute habituation period in groups of 5 conspecifics, calves were individually tested, and behaviour was continuously recorded for 4 minutes.

Data for 10 calves were analysed using a Mann-Whitney U Test to compare the behavioural responses of -S and +S calves to social isolation. Median values are reported with ranges. When compared with +S calves, -S calves walked more frequently (-S=12, range 7-15 vs +S=6, range 2-10 bouts, p=0.016) and for a longer duration (-S=52.85s, range 23.0-64.9s vs +S=16.6s, range 2.5-47.5s, p=0.032), and displayed vigilance behaviour more frequently (-S=4, range 2-6 vs +S=0, range 0-2 bouts, p=0.08) and for a longer duration (-S=38.0s, range 12-70.8s vs +S=0s, range 0-21.3s, p=0.016). This suggests -S calves perform more stress-associated behaviours when subjected to isolation, possibly indicating lower independence and stronger motivation for social reinstatement. Providing dairy heifers with exposure to social models during early life may improve calves' behavioural responses to stressful social situations.

Additional keywords: Social License, Nanny Cows, Calves, Social Model

Factors affecting productivity and profitability in pasture-based automatic milking systems

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ABSTRACT

A large variability in productivity and profitability between farms milking with automatic milking systems (AMS) has been identified in Australia. This study aimed to identify the physical factors (i.e., production outputs, physical inputs, and productivity measures) associated with profitability and productivity in pasture-based AMS, and to quantify how changes in these critical factors would affect farm productivity. Two different datasets with information from pasture-based AMS farms were utilized. The 'Business Performance Dataset' contained yearly farm business physical and economic data from 14 Australian AMS farms located across five states and collected during financial years 2015-2016, 2016-2017, and 2017-2018. The 'Robot-System Performance Dataset' contained monthly, detailed robot-system performance data from 24 AMS farms located in Australia, Ireland, New Zealand, and Chile, and collected during financial years 2015-2016, 2016-2017 and 2018-2019. Two linear mixed models were used to identify the physical factors associated with profitability (Model 1) and productivity (Model 2). A Monte Carlo simulation was conducted to simulate how changes in the factors identified in Model 2 would affect productivity. Each variable was sampled, individually, from the upper or lower quartile of its distribution to simulate different top-performing scenarios. Model 1 showed that the two physical factors associated with profitability were milk harvested per robot (MH), and total labor on-farm (Model 1 explained 69% of the variance in profitability). Model 2 showed that the physical factors associated with MH were cows per robot, milk flow, milking frequency, milking time and days in milk (Model 2 explained 88% of the variance in MH). The Monte Carlo simulation (Table 1) showed that if pasture-based AMS farms manage to increase the number of cows per robot from 55 (current average) to 71 (top 25% average), they will increase the chances of achieving more than 1500 kg MH (from 24% to 58%) and almost double the overall farm profitability.

Keywords: robotic milking, economics, business analysis, Monte Carlo simulation

Table 1. Monte Carlo Simulation - Effect of top performing scenarios on the key variables averages

Scenario	Milk Harvested	Cows per robot	Milk Flow	Milking Frequency	Time in robot	DIM
Base Case	1,238	55	1.6	2.17	6.7	185
More Cows per Robot	1,581	71	1.7	2.06	6.8	165
More Milk Flow	1,554	58	2.0	2.13	6.8	177
Less DIM	1,369	59	1.7	2.19	7.0	124
More Milking Frequency	1,248	50	1.6	2.55	6.6	179
Less Time in Robot	1,102	54	1.6	2.21	5.8	210

Base case: all variables to the mean, **More Cows per Robot**: > 63 cows robot^{-1}, **More Milk Flow**: > 1.8 kg min^{-1}, **More Milking Frequency**: > 2.36 milkings cow^{-1} d^{-1}, **Less Time in Robot**: < 6.16 min milking^{-1} , **Less DIM**: < 154 days in milk

Context-dependency in the peripartum vocalisations of dairy cows

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Abstract.

Welfare-related contextual information can be reflected in farm animal vocalisations. Despite increasing interest in the vocal behaviour of goats, pigs, horses and laying hens, the information content of cattle vocalisations remains relatively less explored. In this study we recorded the vocalisations and accompanying phonatory behaviours of 19 Holstein-Friesian cows (n = 10 primiparous, n = 9 multiparous) on a commercial dairy farm. Cows were recorded in the two contrasting peripartum contexts of calving with dystocia and immediate fence-line calf separation. Findings revealed that vocal structure was influenced by context or a context x parity interaction, with calving vocalisations being overall higher in start ($P < 0.003$) and minimum pitch ($P = 0.03$), containing more vocal roughness ($P < 0.001$) but less variation around the pitch (all $P < 0.001$) and a lower maximum pitch ($P < 0.001$) compared to calf separation. During calving, primiparous cows emitted calls longer in duration, lower in mean pitch and containing more major pitch modulations compared to their multiparous herd mates (all $P < 0.05$). Cows that were calving also expressed a greater number of open mouth calls, with the tongue visibly protruding in 82% of the primiparous and 10% of the multiparous cow vocalisations. By contrast, calf separation led to more vocalisations emitted with a mixed mouth configuration, containing both closed and open mouth components. Together, the open mouth configuration, tongue protrusion and vocal properties such as longer duration and overall lower pitch likely enhanced the vocal transmission over longer distances during calving, to inform the farmer and herd mates about the higher urgency of this context. Knowledge of these context-related vocal variations and phonatory behaviours could be used in future studies to assess individual cow welfare aurally and visually over the peripartum period.

Additional keywords: Calf separation, calving, phonatory behaviour, vocal communication, welfare

Maintaining dairy cows and calves together in a pasture-based system: Behaviour and productivity through to weaning

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Dairy cows and calves are routinely separated within 24h postpartum. There is limited literature evaluating pasture-based dairy cow-calf systems. We evaluated the productivity and behaviour of dairy cows and calves kept together on pasture for 100 days and cow behavioural response to weaning. Six Holstein-Friesian cows and their male calves were enrolled in the study (n=12). Cows were temporarily separated twice a day for milking. Behaviour was recorded via scan sampling for the first 7 days, and then twice a week thereafter. Daily milk yields and weekly calf weights were collected until calves were fully separated from the cow (113 ± 10.43 days in milk) and immediately processed for rumen development analysis. Six control cows (calf removal at 24h postpartum) were added after treatment calves were weaned to compare the behavioural response to full separation. Cow behaviour was recorded for 3 days following separation. During rearing, cows were observed near their calf and nursing more in the first two weeks. Turn arounds and vocalisations during separation for milking decreased over time (P<0.001). Milk yields averaged 12 ± 7.6 L/day for the 3 days before full separation and increased to 31 ± 8.3 L/day the 3 days after calf removal. Average daily gain of calves was 1.42 ± 0.7 kg/day. The average rumen tissue weight was 2.02 kg. After full separation, experimental cows vocalised more than control cows across the 3 days (P=0.01). However, control and treatment cows were similar for close to fence, standing, lying, walking and eating behaviours. Experimental cows ruminated (P<0.001) and were more active (P=0.001) than control cows. We have demonstrated the ability to rear cows and calves together for up to 100 days by animals learning the system, accelerated calf weight gain with the cost of sellable milk, adequate calf rumen size and similar cow behaviour responses to separation.

Key Words: Rearing, weaning, growth, average daily gain (ADG)

Impact of Post-grazing Residual Height and Concentrate Feeding on Enteric Methane Production in Lactating Cows

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Abstract

Feed management for dairy cows influences milk production and enteric methane (CH_4) emission. This study focused on investigating the impact of pasture post-grazing residual height (PGRH) and supplementary feed management on enteric CH_4 emission of dairy cows. Thirty-two mid-lactation Friesian x Jersey cows were divided into two pasture only PGRH (3.7 cm and 4.6 cm), and two pasture PGRH plus concentrate supplement (3.6 kg/day/cow) groups. Each treatment had eight replicates. Dry matter intake (DMI) and production performance were measured daily for 24 days. The mean group pasture DMI was estimated using the difference between pre- and post-grazing pasture mass and the grazed area of pasture. Then, the total estimated pasture DMI was divided by the number of cows in a particular group to get the average DMI (kg DM cow $^{-1}$day^{-1}). The CH_4 emission was estimated as: CH_4 (kg CO_2-e/day) = (1.23 * DMI (kg/day)) – (0.145 * Fatty Acid (g/ kg DM)) + (0.012 * Neutral Detergent Fiber (g/ kg DM)) * 28/55.65. The global warming potential of CH_4 was considered as 28 compared to CO_2 and energy generated by CH_4 was considered as 55.65 MJ/kg in these calculations. Data were statistically analyzed using GenStat (Version 16). One-way analysis of variance (ANOVA) was conducted for measured parameters. Enteric CH_4 emission was greater in cows fed pasture plus concentrate (11.6 kg CO_2-e/day) compared to pasture-only cows (10.8 kg CO_2-e/day). However, enteric CH_4 EI (CH_4/kg fat and protein corrected milk (FPCM) was similar (0.5 kg CO_2-e/ kg FPCM) between the two treatments. The PGRH had no effect on estimated enteric CH_4 emission, and CH_4 EI in this study because both groups of pasture had similar nutrient and botanical composition. However, the high energy concentrates increased the FPCM production, which in turn help to achieve a higher level of on-farm milk production under the same level of enteric CH_4 emission.

Additional keywords: Methane, Enteric, Emission, Pasture, Concentrate