

Scotland's Rural College

Effects of warm climatic periods on dairy cow behaviour and production in Scotland

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Print publication: 20/11/2023

Document Version

Publisher's PDF, also known as Version of record

[Link to publication](#)

Citation for published version (APA):

Haskell, MJ., Sullivan, I., March, M., & Shewbridge Carter, L. (2023). *Effects of warm climatic periods on dairy cow behaviour and production in Scotland*. Paper presented at Next Generation Dairying, Edinburgh.

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HDRF Conference 2023:
Next Generation Quality Dairying

Hannah Dairy Research
Foundation



Journal of Dairy
Research

Edinburgh, November 20th and 21st 2023

BULLETIN BOARD AND ORAL ABSTRACTS

Faba bean as a foundation for climate smart crop- and feed-systems

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Towards enhancing the sustainability and resilience of the UK's crop- and feed-systems, this presentation summarises the objectives and initial insights from a key project undertaken by the Agroecology Group (Department of Ecological Sciences), of the James Hutton Institute (JHI) and associated partners. There is a focus on the DEFRA-funded, 'Nitrogen efficient plants for Climate Smart arable cropping systems' or 'NCS' Project (www.ncsproject.co.uk; 2023-27), which comprises 18 industry and research partners to empower the production and processing of UK-grown faba beans. Their approach aims to reduce the GHG emissions of UK agriculture by 1.5 Mt CO₂e per annum, which is 54% of the maximum potential reduction (2.8MT) of the UK ag-industry (Defra Agri Climate Report, 2021; <https://www.gov.uk/government/statistics/agri-climate-report-2021/agri-climate-report-2021>). Half of the reduction (0.7 MT CO₂e) would be attained by replacing 50% (1.8 MT) of imported soybean meal (SBM) with home-grown beans. The remainder of the CO₂e savings achieved mainly via reductions through avoided synthetic nitrogen (N) fertiliser use and N-losses, plus faba bean-based feed formulation. The innovation pipeline to achieve this will be described, including with the details on how you may get involved in NCS-Project activities, and outputs.

In addition to quantifying the potential GHG savings from legume-based feed systems, it is also critical to account for other system attributes, such as ecosystem-services, or -functions, including water quality and soil processes. Therefore, we elaborate on recent findings that highlight the importance of long-term cropped system monitoring, and methodological approaches that integrate ecosystem-impact and -function metrics. Data from JHIs 'Centre for Sustainable Cropping' Life Cycle Analysis (LCA) of cropped systems is used to inform and develop the larger scale 'land use risk assessment' model, GOBLIN (Duffy et al., 2022a, 2022b; <https://doi.org/10.5194/gmd-15-2239-2022>, and <https://doi.org/10.1038/s41893-022-00946-0>, respectively). This innovative and ambitious approach aims to allow the assessment of ecosystem-impacts and -functions to be made across scales; and to identify how these may be best-harmonised using scenario analysis.

Other tied projects will also be highlighted: including resources generated by research and innovation efforts which have recently concluded, and others which are currently underway or scheduled to begin in 2024.

Optimising the temporal distribution of dietary protein in early lactation dairy cows

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During the first two to three weeks of lactation (fresh period), dairy cows experience negative protein balance when requirements for maintenance and milk production exceed intake, and amino acids are

mobilised from body tissue. As well as providing substrate for immediate milk protein synthesis, extra amino acids supplied at this time may promote mammary cell proliferation and/or influence nutrient partitioning, exerting effects beyond the fresh period. Previous research demonstrated that abomasal infusions of casein increased milk protein yield during the fresh period, with this difference potentially persisting into later lactation. However, this effect has not been translated into practical feeding strategies for implementation on commercial dairy farms using representative UK diets. We hypothesise that milk protein yield and nitrogen use efficiency in early lactation (defined for the purpose of this experiment as the first 49 days) will be higher when, for a given amount of dietary protein provided in early lactation, a higher proportion of that protein is offered during the fresh period. Forty multiparous Holstein-Friesian cows (blocked into two cohorts of 20 based on calving date) will be paired at calving and allocated within pair to one of two dietary treatments for the first 49 days of lactation. Treatment A (control) is a total mixed ration (TMR) formulated to contain 172g CP/kg DM. Treatment B comprises two TMRs formulated to contain 222g CP/kg DM (offered from day 1 to 14 of lactation) or 156g CP/kg DM (offered from day 15 to 49 of lactation). Using predicted dry matter intake, total intake of CP during the experiment is calculated to be the same for both treatments. Measurements are individual dry matter intake, milk yield and composition, body weight, body condition score and body fat and muscle depth (assessed by ultrasound). The first cohort of 20 cows have completed the experiment. The pattern of milk urea concentration throughout the experiment mirrored dietary CP concentration, confirming different patterns of protein consumption, as planned. Data analysis, and work with the second cohort of cows, is in progress.

Extended colostrum feeding – beyond immunoglobulins

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As soon as possible after birth, calves need to ingest an adequate volume of high quality (>50g/L, It has long been understood that colostrum is rich in immunoglobulin and high in protein and fat (making it a highly nutritious feed for newborn calves). In addition, there is evidence that antibodies remaining in the gut lumen after colostrum feeding also provide local immunity against enteric viral infections and diarrhoea caused by bacterial enterotoxins and may enhance intestinal villus development (Snodgrass et al., 1980, 1982; Saif and Bohl, 1983; Buhler et al., 1998). More recent research has focussed on other colostrum components including lactoferrin, lactoperoxidase and lysozyme (Steinhoff-Wagner et al., 2011, Pyo et al., 2020, Carter et al., 2022). Colostrum oligosaccharides and fatty acids provide an immune regulating function which may improve GIT health, systemic inflammation, and oxidative status (Fischer-Tlustos et al., 2020; Ogenorth et al., 2020). Colostrum is also rich in microRNAs which are important for the development of the intestines, stimulating cell viability, proliferation, and stem cell activity of the intestinal epithelium and they may act as key players in the development of the complete immune system (VanHese et al., 2020).

As the wealth of knowledge on colostrum components beyond immunoglobulin has grown, published literature has focussed on the benefits of extended colostrum and/or transition milk feeding on calf health and productivity. There are several reasons to feed colostrum in an extended manner, including: increasing serum IgG concentrations; reducing antimicrobial use; increasing immune protection for specific dam vaccinated pathogens; improving average daily gain and promoting intestinal villi development; reducing calfhooood morbidity and mortality and improving reproductive and lactation outcomes.

The University of Glasgow are currently conducting research on two Scottish dairy farms on the

benefits of transition milk feeding in dairy calves. In this preliminary presentation we review the current literature on extended colostrum feeding and the other components in colostrum beyond immunoglobulins.

Investigating the presence of benzimidazole resistance in gastrointestinal nematodes in Scottish dairy cattle

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Gastrointestinal nematodes (GINs) are a health and production threat for all grazing livestock. Anthelmintics have been widely used to control these parasites for many years. However, in recent years the emergence of resistant parasite strains has become a recognised threat to the industry. This study aimed to investigate anthelmintic resistance within Scottish dairy farms. Four conventional dairy farms from the greater Glasgow area were included in this study during the 2023 grazing season. Serial faecal egg counts (FEC) were conducted on first grazing season cattle (minimum of 30 animals) for each herd from early July to ensure a minimum FEC before treatment commenced. When FECs were above 80 eggs per gram (epg), a Faecal Egg Count Reduction Test (FECRT) was started. Individual animal faecal samples were obtained then cattle were treated with either Ivermectin (Ivomec, Boehringer Ingelheim), Moxidectin (Cydectin, Boehringer Ingelheim) or Benzimidazole (Panacur 10%, MSD), randomly to ensure no bias. Cattle were individually weighed and given the correct dosage of anthelmintic as per manufacturer guidelines to ensure accuracy of treatment. On one larger farm, a group of cattle (n= 18) were left untreated as a control group. Repeat individual faecal samples were taken 14 or 15 days post treatment, and pre- and post-treatment FECs were compared. Additionally, egg hatch tests (EHT) were carried out on pre-treatment faecal samples to investigate potential for benzimidazole resistance within the GIN population. This test allows a better understanding of the GIN population within these farms. For two farms the EHT's could not be accurately read due to excess faecal debris. The EHT on the two farms which were completed did identify resistance on one, with the concentration required to prevent 50% of the eggs from hatching (EC50 value) being higher than the published EC99 value for sensitive isolates. The other farm had a low hatch percentage of eggs in all wells this could indicate this population is not resistant. Alternatively, it may indicate an issue with the test or the isolated eggs. This study highlights the need for continued surveillance of anthelmintic resistance.

Evaluation of the prevalence of *Coxiella burnetii* in Scottish dairy cattle: a cross-sectional study

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Coxiella burnetii is an obligate intracellular, gram-negative bacterium that is suspected to be linked to reproductive failures and reduced milk yields in dairy cattle. A cross-sectional study was undertaken at a herd with a history of *Coxiella burnetii* detection with the aim of determining the proportion of animals in different management groups that were seropositive and qPCR positive for *Coxiella burnetii*. Sampling was performed at the main farm and two linked

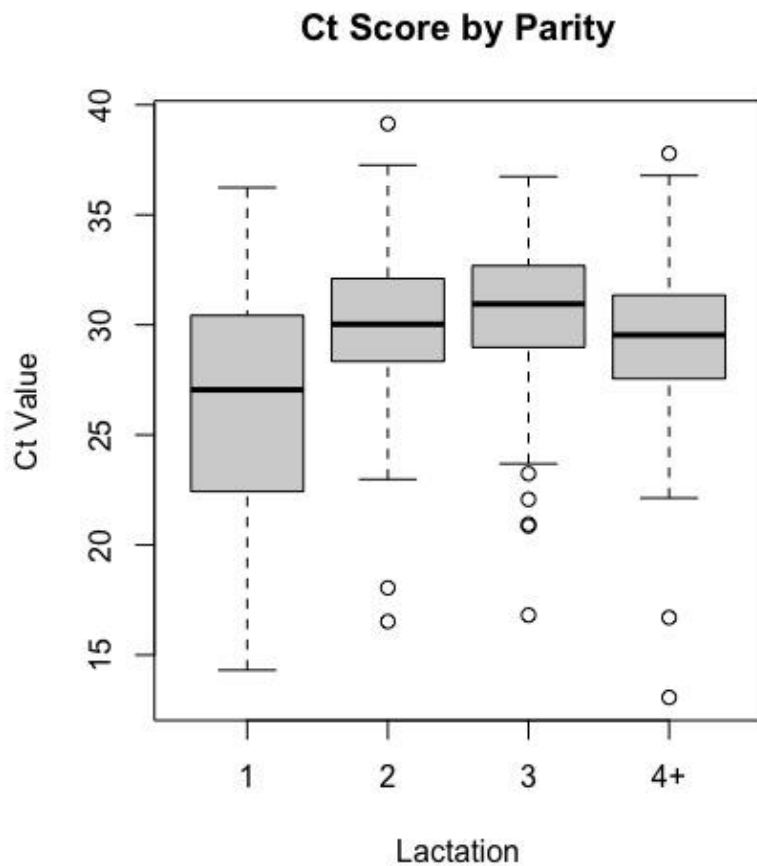
heifer units. Blood samples and vaginal swabs were collected from a target of 30 animals in each of six management groups: pre-bulling heifers at heifer unit 1, pre-bulling heifers at heifer unit 2, pre-calving heifers at unit 2, pre-calving heifers at the main farm, heifers in milk at the main farm, and animals in the main milking herd. Sera were tested by LSIVet Ruminant Q Fever- Serum/Milk ELISA at the Biobest Laboratories and samples with sample:positive ratio > 40 were classified seropositive. Vaginal swabs were stored in DNA/RNA shield and heat treated at 70C for 1 hour prior to DNA extraction. Swab extracts were qPCR tested using an assay that targeted IS1111. A sample was considered positive for *C. burnetii* if amplification with Ct A total of 158 animals were sampled in June 2023. Only two animals from the heifer units were seropositive (= 70% animals in all management groups). *C. burnetii* exposure and infection were widespread in this herd. The serological data indicated that seroconversion of the majority of animals occurred at the time that they move to the main farm. The qPCR data indicate high prevalence of shedding in all groups, including animals at heifer units. Future studies would be valuable to investigate the implications of infection for reproductive performance and lactation in these dairy cattle.

Cross sectional investigation of *Coxiella burnetii* following parturition: A new spotlight on a neglected zoonotic disease in Scotland

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Suboptimal fertility and increased rates of post-partum reproductive disease were reported by a high-producing commercial Scottish dairy farm in 2021. The farm tested positive for *C. burnetii* in bulk tank milk by PCR and ELISA. The objectives of this study were to investigate the within-herd prevalence of *C. burnetii* on this commercial dairy farm and identify variables associated with pathogen shedding. A 900-cow dairy farm in Scotland was recruited in this study following positive screening for *C. burnetii*. Vaginal swabs were collected from post-partum cows during routine checks performed within seven days of parturition. Samples were stored in DNA/RNA shield, heat treated at 70oC for ≥1 hour then processed. DNA extracts were qPCR tested for *Coxiella burnetii* using an IS1111 assay, an insertion sequence found 5-100 times in its plasmid. qPCR assays were run for 40-45 cycles. Samples were considered “negative” if they did not amplify or amplified with a Ct ≥ 40. If amplification occurred with Ct values 35-40 samples were considered “inconclusive”. Samples with Ct values 27-35 were considered “positive” and samples with Ct values A total of 324 swabs were collected between Dec 2022 and Jul 2023, of which 310 (95.6%) had detectable *C. burnetii* with Ct ≤ 40. Of these, 17 (5.2%) swabs were classified as “inconclusive”, 232 (71.6%) swabs were classified as “positive” and an additional, 61 (19.8%) swabs were classified as “high load positive”. All primiparous cows scored Ct qPCR data indicates diffuse shedding in the herd and many animals shedding high concentrations of bacteria. The association between increased milk production (higher 305ME) and higher Ct (lower bacterial loads) indicates potentially important production impacts of infection. Further investigation should take place to assess herd-wide effects of coxiellosis.



Point-of-need nucleic acid test for *Staphylococcus aureus* enterotoxin genes in ruminants' milk

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Staphylococcal food poisoning (SFP) occurs after consumption of food containing *Staphylococcus aureus* enterotoxins (SE), causing significant gastrointestinal symptoms and potentially leading to hospitalization. Despite its repercussions on public health, epidemiological data on SFP have been limited, especially in low- and middle income countries. Detection of staphylococcal enterotoxin genes relies on conventional nucleic acids tests, either directly in food samples or after culture of *S. aureus*, which requires specific expertise and equipment, is time consuming and has limited their use during outbreaks and their availability at the point-of-need. Here we present the development of a “sample-to-answer” isothermal nucleic acid loop-mediated amplification (LAMP) assay in a handheld microfluidic device for the detection of *S. aureus* enterotoxin genes in ruminants' milk. A multiplex LAMP assay for two enterotoxin genes, SEA and SEB, was integrated into a microfluidic biosensor combining milk sample preparation (dilution), isothermal amplification (heating) and lateral flow detection for easy readout (results). The limit of detection was 104 Colony Forming Units (CFU)/ml in 1:10 diluted spiked milk samples, which is more sensitive than the European recommendation for raw

milk (105 CFU/ml), without any cross-reactivity in detecting other *S. aureus* strains or other food poisoning pathogens tested. We combined the simplicity of use and rapidity of microfluidic biosensors with the sensitivity and specificity of an isothermal nucleic acid-based tests to guarantee the safety of milk and dairy products.

Genomic analysis of the bovine mastitis pathogen *Streptococcus uberis*

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Streptococcus uberis is a leading cause of bovine mastitis in Scotland and worldwide, contributing to significant economic losses and large-scale antimicrobial use. To gain a better understanding of the biology of this mastitis pathogen, we conducted genome sequencing on 321 Scottish isolates from bovine mastitis and performed a comprehensive bioinformatic analysis. This analysis was complemented by inclusion of 340 sequenced isolates from various other countries and host species. Our analysis led to the construction of a phylogenetic tree revealing, with high resolution, the relatedness of isolates at both the Scottish and global levels. The results show a highly diverse and under-sampled *S. uberis* population, with recombination events across the genome playing a major role in generating this diversity. Furthermore, we used the genome sequencing data to explore within-farm diversity, compare isolates from clinical and subclinical mastitis, investigate the relationships between antimicrobial resistance genotypes and phenotypes, identify novel virulence factors, and characterize the prophage content of the isolates. Our large-scale genomic study is yielding novel insights into various aspects of *S. uberis* biology relevant to its role as a major bovine mastitis pathogen. Genome sequencing of *S. uberis* and other mastitis pathogens, and the insights this provides, may serve as a foundation for future strategies to tackle bovine mastitis and antimicrobial resistance.

The impact of freezer temperature, storage duration, and glycerol cryoprotectant usage on clinical mastitis culture results

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It is common practice for bovine clinical mastitis samples to be stored in freezers for varying periods of time before being sent for diagnostic culture. Storing clinical mastitis samples at -20°C affects bacterial culture results when compared to the culture of fresh samples. Glycerol is an effective microbial cryoprotectant, however, it is not common practice for mastitic milk to be suspended in glycerol prior to freezing.

The objective of this study was to identify the impact of freezer temperature, storage duration and glycerol cryoprotectant usage on culture results from clinical mastitis milk samples. The study employed a 3 × 3 factorial design which included storage temperature (fresh, -20°C and -80°C) and duration (within 24 hours, 1 week and 1 month) and a 3 × 3 × 3 factorial design, including the previous factors and glycerol levels (no glycerol, 15%, 30%). A total of 7 clinical mastitis cases (6 cows) were investigated. All samples were collected aseptically following National Mastitis Council guidelines after detection of clinical mastitis, and before antibiotic administration. Samples were sent for bacterial and fungal culture (SRUC Veterinary Diagnostic Services). Sample cultures without glycerol were affected by storage duration and temperature (Table 1). In case 1, the Gram-negative bacterium *Serratia liquefaciens* and the yeast *Pichia fermentans* were detected in the fresh aliquot. However, after 1 week at -20°C, yeast was no longer detected, with all other treatments resulting in sterile cultures. In case 2, a *Klebsiella* species was detected after 1 week at -80°C, but all other treatments resulted in sterile cultures, including the fresh aliquot. When glycerol was added to samples, storage temperature and duration did not affect the cultures, including those with no glycerol added. All microbes identified are either known mastitis causative pathogens or opportunistic pathogens. This study suggests that storage conditions prior to culture may affect mastitis culture results, potentially impacting pathogen identification and downstream treatment. The effect of using glycerol as a cryoprotectant was inconclusive in this study, potentially due to both causative agents being Gram positive bacteria – which have greater resistance to freezing compared to Gram negative bacteria.

Table 1. Culture results of aliquots of mastitic milk samples subject to different storage conditions (temperature, duration, and inclusion of glycerol as cryoprotectant)

Duration	Temperature (°C)	Glycerol (%)	Case 1	Case 2	Case 3	Case 4 ¹	Case 5	Case 6
Fresh	Room temperature	0	<i>Serratia liquefaciens</i> & <i>Pichia fermentans</i>	Sterile	Mixed growth	(1) <i>Bacillus cereus</i> ; (2) sterile	<i>Trueperella pyogenes</i>	<i>S. dysgalactiae</i>
1 week	-20	0	<i>Serratia</i> spp.	Sterile	<i>Streptococcus dysgalactiae</i>	(1) <i>Bacillus cereus</i> ; (2) sterile	<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		15					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		30					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
	-80	0	Sterile	<i>Klebsiella</i>	<i>S. dysgalactiae</i>	(1) <i>Bacillus cereus</i> ; (2) sterile	<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		15					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		30					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
1 month	-20	0	Sterile	Sterile	(Not cultured) ²	(awaiting)	<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		15					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		30					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
	-80	0	Sterile	Sterile	(Not cultured) ²	(awaiting)	<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		15					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>
		30					<i>T. pyogenes</i>	<i>S. dysgalactiae</i>

¹ Case 4: this cow had 2 teats affected with clinical mastitis. Shaded cells are non-applicable cases.

² Case 3 was not cultured at 1-month timepoint due to extended storage time in the freezer beyond the 1-month timepoint.

Dairy sheep and goat farmers: socio-demographic characteristics and their associations with health management and performance on farms

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The objectives were to determine the socio-demographic profiles of small ruminant dairy farmers and to study associations with management practices, production outcomes and health parameters on their farms. In total, 325 sheep flocks and 119 goat herds across Greece were included in the study and visited for collection of information. Socio-demographic characteristics of the dairy farmers and details of management practices, production outcomes and health parameters on their farms were recorded. For the analysis of results, multivariable models were created using mixed-effects logistic regression, with farms as the random effect. Most dairy farmers were male (93.2%), most were full-time professionals in farming (89.4%) and most had a farming family tradition (86.9%). The mean age was 47.0 years and the mean farming experience was 24.3 years. For 17.3% of the farmers, the highest level of education received was primary education, for 54.3% it was secondary education, for 16.4% it was post-secondary vocational training and for 12.0% it was tertiary education. In 35.4% of dairy farms, external farm workers were employed. Of the socio-demographic characteristics, farming experience was associated with geographical location of farms, management system, breed of animals, application of quarantine measures, laboratory evaluation of feedstuffs, ultrasonographic examination for pregnancy diagnosis, application of vaccination against clostridial infections, means of calculation of bodyweight for drug administration to animals, maintenance of colostrum bank, number of annual veterinary visits, annual milk production per animal, number of newborns and somatic cell counts and total bacterial counts in milk. Further, the employment of external farm workers on the farm was associated with management system, machine-milking, number and breed of animals, application of quarantine measures, laboratory evaluation of feedstuffs, ultrasonographic examination for pregnancy diagnosis, number of annual veterinary visits, annual milk production per animal, protein content in milk and number of newborns. The findings indicate that dairy sheep/goat farming is still a family-driven business, but, nevertheless, there are now younger people among these farmers, many of them with post-secondary education. Socio-demographic characteristics may influence the management practices applied, which in turn can have consequences for production and health results of the farms.

Difficulties and perspectives of dairy farmers and cheesemakers in the French Midi-Pyrenees and Auvergne-Rhône-Alpes.

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The present study aims to understand the difficulties encountered by French dairy farmers and cheesemakers and their perspectives. Our investigation was carried out in July-August 2023 in Midi-Pyrenees and Auvergne-Rhône-Alpes regions, France. Twenty dairy farmers and/or cheesemakers

were interviewed face to face to know employees number , age, women number, problems encountered in their work and during covid 19 pandemic, and their perspectives. The average employees number is 3 aged between 32 and 52 years. Interesting, in more than half of the farms and cheese factories visited (55%), there is a female predominance among the staff ($\geq 50\%$). The majority complain of an excessive workload (85%) and few holidays (65%); the women have difficulty in taking care of their babies, cannot accompany their children to school and some children do not even have vacations. Around 44% of farmers judge that the milk price milk is not sufficient. In addition, 20% complain about European hygiene standards, bureaucratic burdens and the lack of qualified employees. Some farmers express their anxiety about urbanization (19%) and presence of wolves in the region (6%). Some farmers (31%) declared that their work is not considered by the agricultural managers and they are always criticized by environmental defenders. During covid 19 pandemic, 33 % found difficulties as feeling isolation, difficulties in imposing health prevention, large cheese stock. However, all the cheesemakers had a better sale after the confinement never seen until now. Regarding their perspectives, 30% plan to reduce their workload by delegating other people for cheese making or automating the farms. Most farmers and/or cheesemakers (70%) wish the continuity and production stability, whereas 30% want to diversify their production as transforming all the farm's milk into cheeses, making other types of cheeses, and developing agricultural tourism. One third (30%) expressed their wish that one of their children take over the farm and/or the cheese factory. Agriculture managers must find a strategy to reduce the workload in order to be able to take more holidays, increase remuneration and/or offer financial assistance for farmers. Also, environmental defenders should find solutions to reduce climate change without harassing dairy farmers.

Effects of warm climatic periods on dairy cow behaviour and production in Scotland

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Global warming is resulting in an overall increase in temperatures and in the frequency of extreme weather events. In dairy cattle, thresholds within the temperature-humidity index (THI) have been used to indicate points at which cattle will likely experience thermal stress (e.g., a THI threshold of 75 predicts thermal stress). However, high-yielding dairy cows that reside in temperate maritime climates may experience some degree of thermal discomfort below this threshold particularly when they are housed. Housing often results in high levels of humidity. The use of technology such as activity monitors and automated intake measures allow us to monitor responses. The aim of this study was to use technological solutions to assess behavioural changes in response to moderate increases in THI levels. Data from dairy cattle on an experimental unit were used. Data on daily lying times, lying bout frequency, step count, feed and water intake and milk yield were extracted for 8 pairs of warmer (THI<65) and 8 matching cooler (THI=43 to 60) periods. Warm and cool periods were no more than 5 weeks apart to ensure that the data from the same animals were being compared. The first three days from each period were analysed. Results showed that total daily lying time was shorter during warmer periods than cooler periods ($P<0.05$; means and SEMs (h): warm: 11.3 ± 0.06 h; cool: 11.8 ± 0.06 h). However, there was no effect of THI level on the no. of steps taken by cows ($P>0.05$ (counts) warm: 868 ± 8 steps; cool: 878 ± 9 steps). Water intake was higher during warm periods ($P<0.05$: (l) = warm: 81.2 ± 0.7 l; cool: 72.1 ± 0.6 l), but there was no difference in feed intake (warm: 57.6 ± 0.5 kg; cool: 57.1 ± 0.3 kg). Milk yield was lower during warm periods than cool periods ($P<0.05$; (l): warm: 31.8 ± 0.3 l; cool: 32.5 ± 0.3 l).

cool: 32.7 ± 0.2). This suggests that behaviour and milk yield are mildly adversely affected even in conditions that are not regarded as exceeding cows' ability to cope with thermal challenge.

Validating accelerometer technology to detect play behaviour in weaned dairy calves

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Animal welfare, in particular calf welfare, is an increasingly important subject that is gaining interest from multiple stakeholders within the dairy industry. The drive for higher welfare standards has increased the need for research to better understand the needs and nature of animals. Play behaviour is commonly observed in young animals and is regarded as an indicator of positive welfare states. Traditional observational methods of measuring animal behaviour can be labour intensive and impractical for on farm assessment or for studies of long duration. The increase in commercially available accelerometer technology has allowed for detailed analysis of animal behaviours, such as play, in a more efficient manner than continuous visual observations. Accelerometers have been validated for detecting play behaviour in newborn (≤ 48 h old) calves but not in any other age group of cattle. Therefore the objective of this study was to determine the ability of accelerometers to detect play behaviour in weaned dairy calves. Eight weaned female Holstein-Friesian calves (aged 3-5 months) were recruited from a 50-cow dairy herd in central Scotland. Accelerometers (IceTag, Peacock Technology) were attached to one hindlimb of each calf for a 48-hour period. Sensor activity data including step counts, lying times and a measure of overall activity termed "motion index (MI)" were downloaded at the end of the study period in 15-minute intervals. Calf behaviour was filmed continuously over the same 48-hour period and analysed using one-zero sampling to identify the presence (1) or absence (0) of play within each 15-min interval corresponding to the IceTag data output. A significant, positive correlation between MI and visually recorded play was found ($r=0.59$, $p<0.01$) and therefore this output metric was selected for further analysis. Using 2x2 contingency tables and Classification and Regression Tree (CART) analysis, it was determined that the MI threshold which best correlated with visual identification of play behaviour was $MI \geq 123$ (sensitivity = 95.6%; specificity = 93.6%; balanced accuracy = 94.6%). The results suggest that IceTag generated MI data can be used as a more time efficient alternative to visual analysis to detect weaned calf play behaviour.

Addressing purpose and subjective data labelling challenges in automated lameness detection for cattle with machine learning and micro-Doppler radar

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Automated lameness detection in cattle using micro-Doppler radar technology has shown proof of concept. To develop it for commercial application it is essential to address specific issues concerning the labelling process and notification objectives for these systems. Labelling subjectivity and the choice of a scoring system are central challenges in the development process, as the effectiveness of AI systems relies on the quality of labels on training data, which is usually generated through human observations and annotations. Labelling of mobility can be subjective due to variations in human

assessors' interpretations of lameness severity, leading to inconsistencies in the training dataset. To address this, it is necessary to establish clear and standardised guidelines for assessors, examine inter-assessor agreement, and employ labelling approaches that can reduce variation. The scoring system used to label mobility is an important determinant of the sensitivity and specificity of the automated system. The choice of scoring system must align with the specific objectives of the automated system. For instance, a scoring system optimised for high sensitivity might emphasise early lameness detection with the acceptance of false positives. In contrast, a system designed for high specificity would prioritise minimising false alarms, even if this results in missing some lameness cases. Clearly defining the system's intended purpose and notifying users of its functional requirements is critical to managing expectations and optimising the automated system's performance. To address these challenges for the micro-Doppler system, alternative approaches are being explored. One pivotal shift involves the consideration of unsupervised machine learning (ML) techniques for analysis, departing from the previously employed supervised methods. While unsupervised ML offers the potential to enhance the accuracy of lameness detection, it should be noted that this transition is constrained by the absence of a concrete reference to compare against the results. We are also investigating the application of statistical methods to extract relevant features from micro-Doppler radar data and use them to create individualised reference baselines for each animal, which may offer a basis for comparison across recordings. While this approach shows promise, its effectiveness relies on the ability to identify consistent and informative features and on the assumption that deviations from these baselines will accurately indicate lameness. It is essential to acknowledge that the success of these methods is contingent on several factors, including data quality, feature selection, and the complex nature of cattle behaviour. Ongoing research and validation studies are being investigated to determine the practical feasibility and effectiveness of these strategies in real-world farm settings.

Calf management: The effect of single and paired housing on dairy calf health and welfare

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There have been a number of welfare concerns raised about the individual rearing of dairy calves in early life, such that the practice is now not allowed for many UK dairy farmers under a number of supermarket-aligned contracts. Using a non-randomised control trial, this project examined the effects of individual versus pair-rearing of dairy calves on calf productivity (assessed via Average Daily Live Weight Gain (ADLWG), health (morbidity and mortality) and welfare assessments (assessed using a number of behavioural measures including latency to feed and latency to approach a novel object test, as well as salivary cortisol measurements). The hypothesis was that pair-rearing dairy heifer calves from birth to 2-4 weeks of age compared to individual rearing will provide long-term benefits in calf performance, health and welfare. The project was based on a 450 cow Holstein Friesian dairy herd (predominantly autumn calving), and recruited 131 heifer calves onto the trial. Calves were allocated at birth to being either A) penned individually and B) as pairs from birth. The calves were then group housed in batches of 12 calves, whilst continuing on milk feeding. At approximately two months of age, the calves were weaned. The study found that the ADLWG from birth to weaning for individual and paired calves to be 0.63kg and 0.64kg respectively. One individual calf and two paired calves required veterinary intervention for the treatment of diarrhoea. 24% of individual calves and 12% of paired calves required treatment for pneumonia. The median for latency to feed at the first and second feed after batching was 3 and 0 seconds for paired calves, and 9 and 6 seconds for single calves respectively. This study found no detrimental effects of housing calves in pairs compared to single housing under typical UK dairy farm conditions.