CW-01

Effects of postpartum analgesia on the behaviour of Holstein cows experiencing both assisted and unassisted parturition

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Objectives: Assisted parturition in cattle is common and has the potential to be both painful and stressful. Although pain and stress are adverse welfare states, the welfare effects of assisted parturition have rarely been studied. Although non-steroidal anti-inflammatory drug (NSAID) analgesia is commonly provided following veterinary-assisted parturition, conflicting results from different studies mean that the potential welfare benefits of postpartum NSAID analgesia are unclear. Few studies compare cows experiencing both assisted and unassisted parturition, as well as those administered either an analgesic drug or a placebo in a 2x2 factorial design considered 'gold standard' for assessing the welfare effects of a chosen treatment. The objective of this study was to use such a robust design to investigate the effects of postpartum NSAID analgesia in both farmer-assisted and unassisted parturition, as well as the effect of farmer-assisted parturition on dairy cattle welfare in the first 48h postpartum.

Materials and methods: The study was performed on a 700-cow commercial UK dairy farm; the cows are housed all year round and calve in a year-round calving pattern. Thirty-seven cows experiencing farmer-assisted parturition and 35 cows experiencing unassisted parturition were recruited and randomly assigned to either a NSAID treatment group (35 cows) or a placebo group (37 cows). Cows in the treatment group were administered ketoprofen and cows in the placebo group received a saline placebo; both treatments were administered within 3h of parturition. Cow behaviour was monitored for 48h postpartum using continuous video recording. Behavioural analysis of video footage was performed using instantaneous focal sampling with sample intervals of every 20min every other hour. Observations were assigned to behaviours according to an ethogram containing 13 behavioural categories, and were used to construct a 48h time budget for each cow.

Results: The most common specific behaviour exhibited by cows across the whole 48h time period was standing (49% of time budget). Collectively, active behaviours occupied a slightly greater proportion of the time budget than lying behaviours (53.8% compared to 46.3%) and cows were most active in the first 12h postpartum ($p < 0.001$). The most common lying posture was sternal recumbency with the head elevated (26.2%). Lying postures were affected by both treatment status and assistance status. Cows experiencing assisted parturition (irrespective of treatment status) spent more time in lateral recumbency overall than cows experiencing unassisted parturition ($p = 0.008$) and more time in lateral recumbency with the head rested ($p = 0.049$). Cows treated with ketoprofen (irrespective of assistance status) spent less time in lateral recumbency than cows treated with the placebo, both overall ($p = 0.031$) and with the head rested ($p = 0.008$). Additionally, when lying in sternal recumbency, cows treated with ketoprofen spent more time with the head rested than cows treated with a saline placebo ($p = 0.009$). Cows in the treatment group that had experienced assisted parturition showed a tendency to spend more time engaged in feeding directed behaviours than cows in the other three interaction groups ($p = 0.079$).

A diagnosis of postpartum disease was associated with an increased proportion of the time budget spent lying in sternal recumbency with the head elevated and more time lying in sternal recumbency overall ($p = 0.023$ and $p = 0.013$ respectively). Time spent engaged in lateral recumbency with the head rested was 2.5 times higher in primiparous animals than multiparous animals ($p = 0.002$) and as a result, the proportion of the time budget engaged in lateral recumbency overall was also higher in primiparous animals ($p = 0.004$).

Conclusions: Cows that were administered ketoprofen analgesia immediately postpartum exhibited lying postures suggestive of reduced pain and improved comfort, regardless of assistance status. There was no interaction between time and treatment status, suggesting that the beneficial effect of ketoprofen lasted for up to 48h postpartum. A single dose of ketoprofen in the immediate postpartum period therefore has the potential to improve the welfare of all cows after parturition irrespective of assistance status. As parturition is a necessary event for cattle that usually occurs annually, this finding has the potential to contribute to the improvement of welfare of large numbers of cattle and provides a further method for farmers and veterinary surgeons to optimise the management of cows in the immediate postpartum period.

Keywords: Welfare, Behaviour, Parturition, Analgesia.

CW-02

Characterization of Welfare in Dairy Cows Based on WelfareQuality Protocol in Portuguese Farms

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The current consumers are demanding a new approach from the dairy industry. Today we need to assure the consumer that animal welfare is respected. In Portugal, the three largest milk buyers worked together to apply the Welfare Quality® protocol and audit all the farms that sell to our companies. The objective of this study is to characterize the current status of animal welfare in Portugal. We audited 456 dairy farms across Portugal with a number of milking cows varying from 5 to 1232. The main breeds here Holstein-Frisian and the crosses with

Swedish Red and Montbéliarde. The audits were performed as described by the Welfare Quality® referential and consisted of the evaluation of the four main welfare principles: good feeding, good housing, good health, and appropriate behavior. These principles are divided into 12 criteria that allow the auditor to access animal welfare based on the animal and small input from the infrastructure. The combination of these inputs will create a numerical result. Farms results can vary from 0 to 100, being 0 the worst situation an animal can be, 50 a neutral situation of welfare, and 100 the best situation an animal can be in. However, results are presented only on the form of a) Not acceptable - 0 to 20; b) Acceptable - 20 to 55; c) Elevated - 55 to 80; d) Excellent >80. The final score is reached through a complex calculation. Data was collected from September 2019 to March 2020 using the digital platform WFQApp ®, this is a new tool to access the results from the protocol WelfareQuality ®. WFQApp allows direct data input reducing the human error and the desk time after the audit, it also allows the auditor to have access immediately to the results and the report to the farmer. Data was analyzed using the statics program R version 3.6.3.

The 512 Farms were divided in 4 groups based on the number of milking cows: very small <20 (n=75); small 21<50 (n=206); medium 51<250 (n=213); Large >250 (n=18). From these 512 farms, we were able to audit in 447 farms to date, the results of these farms were: Not approved-10, Acceptable-177, Elevated -260 and none was Excellent. There was no difference (p>0.05) nor a correlation between the size of the farm and the results. The main reason for the Not approved farms is related to a low value in all the principles, especially on good feeding. Regarding the remaining audited farms, the areas most found to need improvement were increases in size and/or a number of water throughs and reductions of skin lesions mainly through better bedding.

In conclusion, this is the first large scale characterization of the welfare status in dairy farms in Portugal. The results show that 41% of the audited farms are below what is considered neutral for animal welfare. Therefore, there is still a long path to improve animal welfare in dairy farms in Portugal. This path should include continued auditing and farmer's education.

Keywords: Dairy, Welfare, WelfareQuality, Cows.

CW-03

Opportunities for enhancing welfare in the Australian dairy industry

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Objectives: Public perceptions influence what we farm, and how we farm it.

Like many global dairy industries, Australia's dairy industry has been thrust into the media spotlight repeatedly, with increasing public concern about many common animal husbandry and management practices. While the industry continues to work towards phasing out or finding viable alternatives to many of these practices, Australian dairy farmers also need to look for novel ways to maintain socially sustainable farming operations. The aim of this study was to investigate opportunities for Australian dairy farmers to move beyond the minimum requirements outlined in the Australian Animal Welfare Standards and Guidelines for Cattle, and identify possible socially acceptable ways to enhance the welfare of dairy cattle across all five domains in the eyes of the public.

Materials & Methods: Using an online survey, social media users were encouraged to respond to open-ended questions pertaining to best possible welfare for cows, considering nutrition, environment, health and behaviour. Participants were also asked to describe what they considered to be the industry's major cattle welfare strengths, challenges, and opportunities. Open-ended question responses were coded for thematic saturation using NVIVO software.

Results: A total of 1378 valid responses were recorded. Many respondents (31.6%) reported having some involvement with the dairy industry and most (78.8%) consumed Australian dairy products. When asked to independently rank the factors they considered when making purchasing decisions (not important; somewhat important; very important) most (77.3%) considered a high standard of animal welfare as being very important. This, and safe food production, were the two factors most commonly reported as being very important amongst respondents. Almost all respondents (95.7%) believed dairy cattle to be sentient. Many (33.7%) reported as having ever signed a petition or attended a rally pertaining to animal welfare. Many respondents (40.9%) felt that they were very informed about dairy farming practices in Australia.

Common themes surrounding best possible welfare across the 5 domains included: access to pasture and sunshine; adequate space and shelter; plentiful and quality feed; social interaction; regular activity; low-stress stock handling practices on farm; positive interactions with humans; access to quality veterinary medicines and care (including pain relief); regular health monitoring and prophylactic treatments; appropriate genetic selection and responsible breeding; hygienic facilities; humane euthanasia; and access to enrichment resources (most frequently noted as scratching posts or cow brushes).

Perceived welfare strengths of the Australian dairy industry included: public trust in farmers to care for their livestock; relatively high standards of national animal welfare on a global scale; smaller scale family-owned farms; a strong community of resilient and collaborative farmers; industry resilience to natural disasters; progressive key industry priorities surrounding animal welfare (particularly targets around provision of pain relief at disbudding; use of polled genetics and sexed semen; the phasing out of induced calvings; management of heat stress; and creating alternate pathways for bobby calves).

Current welfare challenges identified by respondents included: negative public perceptions; lack of enrichment; the potential for compromise of cow health when selecting for production trait; bobby calf management practices; common health issues such as mastitis, eye cancers, prolonged recumbency and lameness; appropriate nutrition and feed availability; cow-calf separation; overuse of antibiotics; underuse of analgesics; short voluntary wait periods; access to appropriate shelter- poor stock handling techniques; painful husbandry procedures; biosecurity; environmental stewardship and sus-

tainability; changing climactic conditions; lack of skilled farm workers; working conditions on farm; farmer physical and mental health; and farm profitability.

Respondents indicated future welfare opportunities for the industry encompassed: improving community engagement; promoting consumption of Australian made or local dairy products; adoption of innovative technologies and automations (including health monitors and voluntary milking systems); continued industry commitment to policy improvements and mandates (particularly around provision of pain relief); processor commitment to ensuring compliance; benchmarking and third party audits; and ongoing research, development, and extension.

Conclusion: Respondents in this study have provided insights into areas for future research and development to enhance public discernment around cattle welfare on dairy farms in Australia. This study reaffirms the need for ongoing industry stakeholder engagement to provide assurances that enhanced welfare across all five domains will improve public acceptability of farming practices. This will ensure the Australian dairy industry retains a social license to operate into the future.

Keywords: dairy, welfare, social license, cow, public perception.

CW-04

Dehorning of calves: Common practice and attitude of 3,267 Austrian farmers

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Introduction: The disbudding of calves is a routine procedure in cattle husbandry. It is a painful intervention, regardless of the method used. The legislation regarding dehorning varies worldwide. In Austria, the legal guidelines were changed in accordance with scientific recommendations in 2017.

In calves younger than six weeks, cauterization is allowed to be done by a qualified person, while in older calves disbudding or dehorning must be performed by a veterinarian. The use of sedatives, local anesthetics and analgesia are mandatory, additionally, drugs for pain management have to be administered by a veterinarian.

Objective: The aim of the study was to evaluate how the new legally required methods were implemented, which management changes were necessary, as well as the farmers´ attitude towards the new regulations.

Material and Methods: Approximately 17,720 cattle breeders taking part in the national milk and beef herd performance testing program (LKV Austria) were included in the survey. An internet-based questionnaire was designed comprising six areas of interest: farm characteristics, producer perception of disbudding-related pain, economic impact and degree of satisfaction with the new situation. Furthermore, the opinion of the farmers about a possible shortage in veterinary care now and in the future was evaluated.

Results: A total of 3,267 questionnaires were returned over a 2 months period, resulting in a response rate of 18.4%. The average herd size of the farms was 37.7 cows, with Fleckvieh as the main breed. In almost 80% of the farms, all cows were hornless. Based on the results of the questionnaire, hot-iron cauterization seems to be the method of choice in Austria.

On approximately 52% of the farms only the young stock kept for replacement was dehorned, on 33% disbudding was performed on all calves respectively.

On 54% of the participating farms cauterization is done by a veterinarian, only on 44.9% disbudding is done by the farmers. Almost 30% of the farmers stated to believe that disbudding caused little or no pain, another 34.1% of the farmers considered disbudding to cause moderate pain and the remaining 36.3% found it to induce a lot of pain. Approximately 61% of the farmers think that pain management medication is worth the money. Sedation is generally considered more important than local anaesthesia. Only 56% of the farmers stated that disbudding is performed in the morning, furthermore only 6.7% of the surveyed farmers dehorned their calves within the third week of life. In most cases the reason for the delayed dehorning of calves is a shortage in available veterinary care.

To be more flexible, 45% of the farmers would like to apply pain management by themselves. The demand for trainings to achieve the necessary skills also was expressed in the questionnaire by many farmers.

Conclusion: Disbudding is still a routine procedure and performed on most of Austrian farms. Not all farmers see the legal chances as a benefit for animal welfare. To reduce costs and increase flexibility many farmers would prefer to apply pain management medication by themselves, which has to be critically valuated, as abuse and misuse of drugs may occur in this case.

Keywords: Dehorning, disbudding.

CW-05

Prediction of calving assistance using a commercially available tri-axial accelerometer

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Objectives: Farmers are recommended to closely monitor cows that may need calving assistance to enable intervention to be optimised; however, this can be difficult to achieve, and it is currently not possible to accurately predict when cows will give birth, or whether they are likely to need assistance. As such, some cows that experience a difficult calving may not receive timely assistance and, conversely, some cows may be assisted unnecessarily — both are situations that may have negative welfare outcomes. The objective of this study was to investigate whether activity data generated by a commer-

cially available tri-axial accelerometers (IceQube, IceRobotics, Scotland) is able to accurately detect cows that subsequently required calving assistance.

Materials and Methods: Eighty Holstein cows on a commercial dairy farm in Scotland were recruited to the study. Ice-Qube accelerometers were fitted to one hindlimb of each cow one to two weeks prior to their expected calving date (all cows were artificially inseminated, and pregnancy confirmed ultrasonographically by a veterinary surgeon). Cows were housed in a group calving pen from the last three weeks of gestation until calving, after which cows were moved to an adjacent postpartum pen. The date and time of calving was recorded by the farmer and confirmed using video footage recorded as part of a wider study.

Activity data generated by the IceQube accelerometers comprises: the amount of time engaged in lying and non-lying behaviours (both presented as absolute time and as a proportion of the time budget), step count (number of steps taken in a defined time period), lying bouts (number of lying bouts in a defined time period; a lying bout is recorded when the cow transitions from standing to lying and back to standing), and Motion Index (a proprietary measure indicative of activity). Accelerometer-generated data were downloaded for 48 h pre-partum and used to construct time budgets that were analysed in 12 h time periods (0 to −12 h, −12 to −24 h, −24 to −36 h, and −36 to −48 h) using Linear Mixed Models and Generalised Linear Mixed Models (Poisson distribution) as appropriate; animal identification number was entered as a random effect into all models to account for repeated measures. Data were further analysed using Classification and Regression Tree (CART) analysis to determine a data threshold for prediction of assisted calving. Thresholds were validated using 5-fold cross-validation.

Results: Multiparous cows were moderately over-represented in the study population (72.5% compared to 28.8% primiparous cows), and most cows (71.3%) did not require assistance at calving. Overall, cows engaged in lying behaviours more than non-lying behaviours in the 48 h pre-partum (54.4% vs. 45.6% of the time budget).

Cows that were subsequently assisted during parturition tended to engage in more lying bouts ($p = 0.064$) and have a higher step count ($p = 0.054$) in the 48 h pre-partum compared to unassisted cows. Classification and Regression Tree analysis supported these results, finding that step count had the greatest association with subsequent assistance status. A step count of 883 was identified by CART analysis as being the optimal threshold for detecting cows that subsequently required calving assistance. Discriminant analysis indicated this threshold had an acceptable sensitivity (69.6%) but low specificity (31.6%), with a positive predictive value of 29.1% and a negative predictive value of 72.0%, for detecting subsequent calving assistance. Additionally, a threshold of 10.5 lying bouts was identified as the optimal threshold for detecting the last 12 h of gestation (sensitivity = 78.8%, specificity = 87.1%, balanced accuracy = 82.7%).

Conclusion: These findings show that IceQube generated data have the potential to be used to predict the timing of parturition and to identify cows more likely to need calving assistance; however, cows less likely to need calving assistance were more accurately detected. Our results could underpin future computational advances and provide a robust basis for future researchers to develop algorithms to identify data thresholds that may be used to alert farmers of higher risk cows, enabling them to direct resources towards ensuring the welfare of these animals.

Keywords: Calving, remote monitoring, accelerometer, prediction, assistance.

Effect of two *vs.* three milk replacer feedings per day on behaviour and stress in Holstein calves

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Objectives: During the early stages of life, calves are very susceptible to stress, so it is necessary to assure a maximal level of animal welfare and health during this period (Kaske et al., 2010). Feed management during this stage has a great impact on animal welfare (Hammon et al., 2020). In nature, calves suckle their mothers more than 6 times a day, but in production systems they are normally milk fed twice a day. Thus, the objective of this study was to compare the effect of feeding milk with different frequency per day on calves' behaviour and stress level.

Materials and methods: The study was carried out in a rearing farm located in Titaguas (Valencia, Eastern Spain) from November 18, 2020 to July 6, 2021. Twenty calves between 4 and 35 days of age were included, and randomly distributed into two treatments according to feeding program: a) group 2T, in which animals received 6 litres of milk replacer distributed in two feedings of 3 litres each and b) group 3T in which animals received 6 litres of milk replacer in three feedings of 2 litres each. The calves were provided with *ad libitum* starter and water from the day of entry and housed individually during 7±2 days after arrival and in pairs until weaning at seven weeks of life.

Blood samples were taken at two moments: 1) Pre-Weaning (1S), when one of the milk intakes had been removed (49.54±5.94d) and 2) Post-Weaning (2S), one week after weaning (66.74±8.2d). IgM, C reactive protein (CRP), serum amyloid-a (SAA) and haptoglobin (HP) were measured with commercial ELISA kits (Cloud-clone CORP. Houston, USA). Behavioural observations were performed by scan sampling every 5 minutes during 2 hours at 0, 2, 6 and 24 hours after the animals were housed in pairs and once per week until weaning.

Behavioural data and blood parameters were analysed us-

ing a cross tabulation and analysis of variance ANOVA (Statgraphics Centurion XVIII®) respectively, using the number of milks feeding as a fixed effect. For blood parameters, the age of the animals was also assessed (1S vs 2S).

Results: Results showed significant differences in all the studied behaviors except walking and inactive between 2T and 3T (Table 1). The 2T animals showed a higher percentage of non-nutritive oral activities (suckling element and suckling empty bottle), as well as aggressive behaviours. Furthermore, these animals showed a higher percentage of eating and rumination compared to the 3T animals. Finally, 3T animals presented a higher percentage of positive behaviors such as exploring, grooming, playing and social interactions. Related to blood stress parameters, the number of feedings did not have any significant effect, whereas the moment of sampling did for SAA (0.0375) and HP (0.0364): animals showed higher values at pre-weaning than at post-weaning. Therefore, the effect of reducing the number of milk intakes previous to the weaning should be considered a stressor agent.

CW-07

Identifying cow temperament to reduce incidence of infectious disease and improve milk yield in early lactation

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Objectives: Animal temperament refers to consistent individual differences in behaviour between animals. These differences can be quantified using standardised behavioural testing or a combination of behavioural and physiological measures. Temperament quantified by behavioural testing is predictive of health and production in dairy cattle (1), however standardised behavioural testing is difficult for producers to implement. This study aimed to determine whether non-invasive physiological measures of temperament could feasibly replace standardised behavioural testing to predict health and production outcomes during early lactation in dairy cattle.

Table 1. Effect of feeding management on the distribution of different behaviors (%).

Milk Feeding	Aggression	Drinking	Walking	Suckling element	Eating	Exploring	Grooming
2T	62.50	30.43	50	82.35	64.52	36.11	29.03
3T	37.50	69.57	50	17.65	35.48	63.89	70.97
P-value	0.047	0.0000	>0.05	0.0000	0.0000	0.0000	0.0000

Milk Feeding	Inactive	Playing	Suckling	Suckling empty bottle	Rumination	Self-grooming	Social
2T	49.55	42.11	33.77	56.67	57.14	59.46	45.95
3T	50.45	57.89	66.23	43.33	42.86	40.54	54.05
P-value	>0.05	0.0000	0.0000	0.0000	0.0081	0.0000	0.0020

Conclusions: Feeding calves three times per day could have a beneficial effect on animal welfare, as it improves positive behaviours and reduces hunger-related and agonistic ones. Nevertheless, this pattern did not present enough effect to alter blood stress parameters, although this could be due to the reduced sample size. Finally, according to the results obtained, gradual weaning (1S) is shown to be a stressful event for calves which has to be accurately handled.

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Keywords: Behaviour, calves, milk replacer, stress, welfare.

Materials and Methods: This study was conducted in 58 Holstein cattle between calving and 60 days of lactation managed in an automatic milking system at Cambridge University Farm, UK. The behaviour of each cow was recorded in a series of standardised tests (human approach, crush restraint, runway and novel arena/novel object (NANO) tests) previously described (2) at 21±4 days of lactation. Animals showing any clinical signs of illness or receiving veterinary treatment at the time of testing were excluded.

Before the NANO test, each animal was fitted with a heart rate monitor (H10, Polar Electro, Finland) around the thorax and left undisturbed for 5 minutes. Intervals between successive heartbeats (R-R intervals) were then recorded for 5 minutes. Immediately following this, temperature of both eyes was measured using an infra-red camera (T335, FLIR systems, UK). Each cow then underwent the NANO test, during which R-R intervals were again recorded, and eye temperature measurement was repeated immediately after the test.

Milk yield at 21 and 60 days were collected from the milking software. Medicines records were used to identify occurrence of clinical infectious disease (mastitis, metritis, interdigital necrobacillosis) during the first 60 days of lactation.

Principal Component Analysis (PCA) in R Studio 2021.09.02 extracted latent variables from behavioural test

data with an eigenvalue ≥ 4/√3 to identify temperament traits. Heart rate (HR) and heart rate variability parameters (root mean square of successive differences, low frequency power (LF), high frequency power (HF) and LF:HF ratio) were derived from R-R intervals. Analysis of variance was used to quantify differences in temperament between animals requiring treatment for an infection and healthy animals. Linear regression was used to quantify the relationship between temperament and milk yield.

Results: PCA identified activity, neophobia, boldness and sociability as distinct behavioural temperament traits. Eleven cases of infectious disease were detected during the first 60 days of lactation: 4 mastitis, 3 metritis and 4 interdigital necrobacillosis. Cows contracting infections in early lactation showed lower boldness (p≤0.01), lower sociability (p≤0.05) lower pre-test eye temperatures (p≤0.05) and higher pre-test heart rates (p≤0.01) than non-infected animals. Milk yield at 21 and 60 days of lactation was positively correlated with boldness (p≤0.01) and negatively correlated with heart rate before and during the NANO test (p≤0.01) and with LF:HF ratio before that test. Eye temperature was positively correlated with boldness (left eye p≤0.01; right eye p≤0.05).

Conclusions: The higher heart rates and LF:HF ratios and lower eye temperatures seen in cattle showing cases of infectious disease and lower milk yields indicated that these animals exhibited more physiological signs of stress. Cattle showing lower eye temperatures also exhibited lower levels of the boldness temperament trait. Previous studies have demonstrated that cattle showing lower boldness and sociability are more susceptible to infectious disease (1) and have lower milk yields (3). The current study extends this to indicate that these individuals can be identified using the physiological measures of heart rate parameters and eye temperature.

As these measures are likely to be more feasible for on-farm use than behavioural tests, they present potential practical methods of identifying individual cattle that are at greater risk of infection in early lactation. Targeting of management resources to reduce risk factors in these more susceptible animals should reduce incidence of infection thereby reducing antimicrobial usage and improving animal welfare.

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Keywords: Dairy, Stress, Temperament, Disease, Thermography.

Correlation between the Welfare Quality° protocol and productive performance in Portuguese dairy farms

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Objectives: The objective of this study was to evaluate the relationship of animal welfare of ten dairy farms in Portugal, with productive performance. We hypothesized that there are positive correlations between Welfare Quality® protocol (WQ) results and milk productive performance parameters, and a negative correlation between the WQ results and mean calving interval (CI).

Methods and materials: Ten farms were used in this study and were visited between January and September 2021. Farm size ranged from 35 to 789 milking cows at the time of the visit. All animals were kept on an intensive-based free-stall production system with several diverse bedding choices and were milked twice a day, with with the exception of one farm where cows were milked three times a day. All farms were assessed for animal welfare using the WQ protocol. The productive performance indicators considered were the CI, average daily milk yield (kg/cow/day), the number of animals reaching 305 days in milk (DIM), 305 DIM cumulative production (kg), and bulk tank somatic cells count (SCC) (cells x10³/ml). Productive performance parameters were obtained and calculated using Microsoft® Excel for Mac version 16.56, and data was obtained from Bovinfor® and Lactinfo©. The descriptive statistical analysis was calculated using RStudio® Mac version 2021.09, and all the proposed correlations were assessed using Spearman's bivariate correlation with a significance level of 5% (p<0.05).

Results: From the farms considered in the study, 80% obtained the WQ "Enhanced" level, while 20% were classified as "Acceptable" as the final score. No farms were classified as "Excellent" or "Not Classified". Table 1 describes the WQ assessment correlations with milk productive performance. Our main results showed that average daily milk yield was positively correlated with the WQ Final Score (p= 0.002), positively correlated with the "Good Feeding" principle (p=0.012) and tended to be positively correlated with "Good Housing" principle (p=0.055). The number of animals reaching 305 DIM was positively correlated with the "Good Health" principle (p= 0,016) and with the "Expression of social behaviors" criteria (p=0.025), and tended to be correlated with the "Good Housing" principle (p=0.053). Finally, 305 DIM cumulative production was positively correlated with the WQ Final Score (p=0.024), with the "Good Health" principle (p=0.002), and with the "Good Housing" principle (p=0.030). There were no significant correlations between the WQ assessment results, the CI, and SCC.

Table 1. Correlation between the final and each Principle score in the WQ protocol, and average milk yield, number of animals reaching 305 DIM, and 305 DIM cumulative production.

WFQ	Average daily milk yield		Number of animals reaching 305 DIM		305 DIM cumulative production	
	ρ	p-value	ρ	p-value	ρ	p-value
Absence of prolonged hunger	0.73	**0.017**	0.53	0.112	0.57	0.084
Absence of prolonged thirst	0.70	**0.025**	0.32	0.372	0.52	0.124
Good Feeding	0.75	**0.012**	0.47	0.173	057	0.087
Comfort around resting	0.62	**0.055**	0.63	**0.053**	0.68	**0.030**
Thermal Comfort	N/A		N/A		N/A	
Ease of movement	N/A		N/A		N/A	
Good Housing	0.62	**0.055**	0.63	**0.053**	0.68	**0.030**
Absence of injuries	0.34	0.328	0.44	0.200	0.66	**0.037**
Absence of disease	0.29	0.421	0.49	0.151	0.3	**0.016**
Absence of pain induced by management procedures	0.40	0.245	0.68	**0.030**	0.56	0.091
Good Health	0.53	0.117	0.73	**0.016**	0.84	**0.002**
Expression of social behaviors	0.50	0.138	0.70	**0.025**	0.53	0.111
Expression of other behaviors	N/A		N/A		N/A	
Good human-animal relationship	0,03	0,934	-0,16	0,651	-0,24	0,510
Positive emotional state	0,62	**0,055**	0,12	0,738	0,32	0,372
Appropriate Behavior	0,30	0,405	0,055	0,881	0,07	0,854
Final Score	0,85	**0,002**	0,563	0,090	0,70	**0,024**

Conclusions: With these results we can accept the hypothesis that dairy farms with better Welfare Quality® scores will have superior productive performance, more specifically higher milk yield per cow per day, more complete lactations, and higher 305 DIM cumulative production.

Keywords: Animal welfare, Welfare Quality®, Dairy cow, Productive performance, Average daily milk yield.
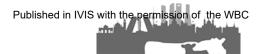

CW-10

Automatic assessment of feeding, ruminating and locomotion behaviours in dairy cows naturally affected by diseases during peripartum period

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Objectives: Changes in cow behaviour are one of the most important criteria to assess animal welfare and health. Several parameters can be used to build up an early disease warning system aiming to gain higher animal health standards, above all during the transition period when a negative energy balance may favour the onset of diseases. Considering the premises, the goal of the study was to assess and compare the feeding, ruminating and locomotion behaviour between cows naturally affected by diseases and healthy cows in the first week after calving.

Materials and methods: Forty-two, free-stall-housed, pluriparous Holstein x Friesian cows were enrolled from 14 days (d) before up to 1 week (wk) after calving. Based on the output of a 3-dimensional accelerometer placed either in a halter equipped with a nose-band sensor or a pedometer [RumiWatch®, ITIN+HOCH GmbH, Fütterungstechnik, Liestal, Switzerland], different feeding, rumination and locomotion behaviors were continuously recorded during this period. *Eating time, ruminating time, ruminating boluses, eating chews, ruminating chews, other activity time* (time spent not in eating, ruminating or drinking), *lying time, standing time, walking time, lie down, stand up, lying bouts, standing bouts, walking bouts* and *number of strides* were the parameters considered. Cows' health status was continuously monitored by means of general clinical examination (every other day) and weekly complete blood analysis [d -14 and d -7 pre-calving, day of calving (d 0)

as well as + d 7 post-calving]. Animals affected by ≥1 disease were considered sick.

RumiWatch® data were converted into 24-hours summaries, and days around calving (d -1, d 0 and d +1) were excluded from the analysis. The mean values of wk -2 (from d -14 to d -8), wk -1 (from d -7 to d -2) and wk +1 (from d +2 to d +7) relative to calving were calculated. Moreover, activities registered on the day, the disease was first clinically diagnosed (dd0), one and two days before disease diagnosis were also described (dd -1 and dd -2, respectively). Lastly, differences between dd0 vs. dd-1 (ΔD1), dd0 vs. wk -1 (ΔD2), and wk +1 vs. wk -1 (Δweeks) were assessed.

Results: At the end of the clinical monitoring phase, cows were divided in group S (n=24 sick cow; all of them diagnosed in wk +1) and group H (n=18 healthy cows). No intra-group difference was observed between wk -2 and -1, for both of them. In group S, eating and ruminating parameters were significantly decreased in wk +1 compared to wk -1, while no difference was detected in group H, for the same time period. In groups S and H, *standing* and *walking time* as well as *number of strides* were significantly increased in wk +1 compared to wk -1. *Lying time* was instead significantly decreased in wk +1 compared to wk -1, in both groups.

Regarding the inter-group difference in feeding and rumination behaviours, at wk +1 and dd0, *eating* and *ruminating time*, *eating chews* and *ruminating chews*, as well as *ruminating boluses*, were significantly lower in group S compared to group H, while *other activity time* was significantly higher. For ΔD2 and Δweeks, the difference between *eating* and *ruminating time*, *eating* and *ruminating chews* was significantly lower in group S compared to group H. Regarding the locomotion behaviours, at wk +1 and dd-2, the *lying time* in group S was significantly higher compared to group H, while the *standing time* was significantly lower. In addition, the *number of strides* was significantly lower in group S compared to group H, at wk +1.

Conclusions: The present study investigates for the first time behavioural changes over time of cows associated with spontaneous diseases. The combined use of Rumiwatch® noseband sensor and pedometer allows to detect the disease state mainly at the day of clinical diagnosis. The model considering the change over time of the variables *eat chews*, *ruminate chews* and *other activity time* achieved the highest accuracy in detecting cows with a health disorder in week +1. The results of the study show that novel precision dairy farming technologies may provide essential support for early disease detection, allowing to improve animals' health and well-being as well as the overall farm efficiency.

Keywords: Behaviour, accelerometer, cow, precision farming, peripartum.

Effects of individual compared to pair housing on behaviour and activity of dairy calves

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Objectives: Behaviour is an indicator of calf welfare, and is affected by both the management system of the farm as well as the health of the animals. It has been shown that calves will exert effort in order to achieve social contact with another, preferring full body contact in comparison to head contact only (Holm et al., 2002). Socialisation by pair housing of calves is now recognised to effect consumption of solid feed (De Paula Vieira et al., 2010; Jensen et al., 2015; Whalin et al., 2018) such that [pair housed calves end up significantly heavier than individually housed calves at weaning (Pempek et al., 2016). However, the behavioural effects of housing type is still limited, so the aim of this study was to establish levels of different calf behaviours (cross sucking, lying times and bouts, novel object approach) between individually and pair housed calves.

Materials and methods: This study was conducted on a single commercial dairy farm in the South-West of England, milking 1800 Holstein and Jersey dairy cows in an all year round calving pattern. Calves were moved from a group calving pen at 12 hours of age into housing within a large shed, using a commercially available partition system (Calf-Tel, USA) that allowed either individual or pair housing of calves until 8 weeks of age. Calves were enrolled between March and May 2020, and were systematically allocated at birth into individual or pair housing groups. Calves were fitted with a tri-axis pedometer (IceQube, Ice Robotics, UK) applied to the hind limb of calves within 1 week of age using a velcro strap. These measured calf activity (via motion index), lying times and lying bouts. A novel object approach study was conducted, with placement of an umbrella into each calf pen during the sixth week of age. The time was measured from placement of the umbrella until it was touched by the nose of a calf, with non-approach given after 10 minutes. In pair pens, the time was stopped when just one of the calves made contact with the umbrella. In addition, a subset of calves had CCTV placed above their pens to enable video analysis on six non-consecutive days to assess cross sucking behaviour and lying proximity of the pair calves to each other. This footage was manually analysed for occurrence of cross sucking on another calf and sucking on inanimate objects.

Results: A total of 90 calves were enrolled, with 23 on individually housed calves and 67 on pair house calves. When assessing calf activity, the motion index was significantly associated with the housing group ($F_{1,83}$ = 440.3, $p < 0.01$), with pair housed calves having a higher mean value of 4503.6 ± 117.5 compared to 4388.0 ± 179.2 in individually housed calves. The Motion Index was significantly associated with the month of enrolement ($F_{1,83}$ = 3.5, $p = 0.019$), and with the occurrence of disease in a calf ($F_{1,83}$ = 3.0, $p = 0.088$), with diseased calves having a lower motion index of 4137.2 ± 153.5 compared to non-disease calves 4678.5 ± 120.7. The Motion Index was not associated with the breed of the calf ($F_{1,83}$ = 2.4, $p = 0.13$). The novel object approach was significantly affected by housing group ($p < 0.01$), with individually housed calves approach-

ing the novel object in a mean of 84.0 ± 9.4 seconds (SEM), and pair housed calves approaching in 121.2 ± 9.2 seconds (SEM). Individually housed calves carried out more sucking on inanimate objects than pair housed calves.

Conclusions: There were significant impacts on calf behaviour associated with the type of housing a calf was kept in. Pair housed calves were more active overall, with activity generally linked to positive welfare indicators. Individually housed calves were significantly quicker at approaching the novel object, suggesting that these isolated calves are more interested in changes to their environment, possibly due to boredom or loneliness. These findings would suggest that pair housing is beneficial for the behavioural welfare of calves.

Keywords: Calf, housing, behaviour, activity.

CW-12

Seasonal pattern in the incidence rate of preweaning calf mortality in a large-scale Hungarian dairy herd

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Objectives: On large scale dairy farms in Hungary, as in most dairies worldwide, preweaning calves are housed outdoors in individual hutches. In summer, it is a usual sight that calves are inactive, cuddled up in the shaded area of the hutch and are panting at a very high rate. Beyond the apparent welfare concern, heat stress can negatively affect animal health and productivity. Heat stress in hutch-reared dairy calves, however, is an overlooked area in the dairy industry. We hypothesized that the thermal stress caused by high ambient temperature in the summer months negatively affects the survival rate in preweaning calves.

Material & Methods: The farm management data of Enyingi Agricultural Ltd. (Kiscséripuszta, Hungary, 47°02'12.5"N 18°21'30.1"E) from 1991 to 2015 were used in the analysis. The farm had an average animal population of 1500-1800 Holstein Friesian cows and their offspring in the studied period. The calves were housed in individual wooden hutches with slate roofs from birth until weaning (around 60 days of age). We collected meteorology data from the National Centers for Environmental Information (Asheville, NC, USA), using the data from the Hungarian Meteorological Service station nearest to the farm (Siófok, Hungary, 46°54'35.1"N 18°02'41.2"E). Weather data included daily mean, minimum and maximum of hourly dry bulb temperature measurements. In the first analysis, we calculated the average daily mortality rates for calendar months and applied the chi-squared test to compare the annual distribution of mortality in the two age groups (0 to 14 vs 15 to 60 days). Second, we determined the average mortality rates of the first age group (0-14 days) in periods of heat stress and thermoneutral periods and compared them by Fisher's exact test. For this purpose, the study period was divided into consecutive 3-day blocks, and those in which the mean temperature was at least 22 °C on each day were considered heat stress periods (risk periods). Blocks with a mean

temperature between 5-18°C on each day served as reference. For comparison, we repeated the analysis with 4-day and 5-day periods and with temperature thresholds 23, 24, 25 and 26 °C.

Results: In the studied period (from 1991 to 2015), 46,899 calves were born on the farm, of which 2,155 died before 60 days of age. The average daily mortality rate of calves younger than two months was 9.64 per ten thousand. The average mortality rate was higher in summer and winter. The monthly distribution of calf deaths differed between the 0-14 and 15-60 day age groups. The mortality risk ratio of the age group 0 to 14 days compared to the rest (15 to 60 days) was above 2 throughout the year. It was highest in July (6.92), the hottest month in Hungary, and lowest in January (2.37). In the second analysis, the mortality risk in the 0-14 day age group was twice as high in periods with an average temperature above 22 °C than in periods of thermoneutrality (mean temperature between 5-18°C). With a daily mean temperature of 25°C or more (heatwaves), the risks were three times as high as in the reference period. Varying the length of the reference and risk periods did not substantially change the calculated measures of association.

Conclusions: Our results provide evidence against the common belief that dairy calves cope well with heat. Increased calf mortality in the hottest month of the year highlights that heat stress abatement in preweaning calves is just as important as protection against cold. Heat stress reduction is advised in outdoor calf rearing when the average daily temperature reaches 22 °C, which is characteristic of summer weather in a continental region.

Keywords: Dairy calves, heat stress, mortality.

CW-13

How dairy farmers perceive Animal Welfare

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Objectives: Animal Welfare is increasingly debated in the broader public, and the dairy sector is more frequently debated for perceived and actual problems around dairy cow husbandry.

While the public debate is generally characterized by statements of conflicting pressure groups, little is known regarding the attitude and perception of dairy farmers. This study tried to collect and categorize the opinions of dairy farmers regarding the subject of animal protection and animal welfare. It was aimed at exploring their perception their attitude regarding the public debate around the topic and challenges on their respective farms.

Material and Methods: Using the method of a semi-structured interview, an interview guide with 15 open questions was developed. A total of 12 dairy farmers from various parts of Germany were interviewed by telephone. Farmers were selected by the technique of theoretical sampling, covering most farm types present in Germany. Three of the interviewed farmers were female, the age was between 25 and 58. The herd-size varied between 60 and 5000 cows. The interviews lasted about 30 mins, were recorded and transcribed. The transcripts were then analysed for the relevant categories and structured accordingly. The results in the different categories were then collected and compared.

Results: The farmers generally define „Animal Protection" close to the wording of the German Law on Animal Protection as legal base for their work. The farmers felt responsible to protect animals from pain and suffering and meet the physiological needs of the animals. All farmers judged their farms having a high standard of animal welfare; on all farms, however, practicable examples for possible improvement were named. Practices as e.g., dehorning or calf separation were seen critically by some farmers. Contrary to the legal term "Animal Protection", the term "Animal Welfare" was not uniformly understood by the farmers. This term was regularly associated as a terminology to be used in marketing and sales of dairy products.

Animal Health was perceived as highly important by all farmers. All rejected the idea to cut costs in therapy or prevention for economical reasons. Prevention was generally preferred over therapy and investments in preventive measures were seen as logical.

All interviewed farmers rejected a negative correlation between herd size and animal welfare. Some farmers stated that larger farms had more opportunity to structure their farms, allowing better trained people to spend more time with the animals; this could have positive effects on animal health and welfare. Problems with farm staff like fluctuation could, however, have a strong negative impact on the Animal Welfare.

Farmers stated that public debate around Animal Welfare issues did not influence their professional attitude and work, nevertheless affected them emotionally. The debate was perceived as being unfair and negative consequences for then economic situation of the sector are expected. While farmers do criticize the knowledge of the consumer public, they say they remain open for discussion and wishes.

In the opinion of the farmers interviewed, weak points of the dairy sector are dehorning, shortage of qualified staff, overburdening of farmers, little appreciation of male calves and the condition of cull cows.

Farmers see a huge potential in animal breeding: In their opinion, genomics offer potential to improve Animal Health and Welfare. Conversely, breeding is getting more complex and needs careful selection. Farmers generally disapprove of a genetic selection towards higher production only.

Discussion: The study offered insight into the ideas and perceptions of dairy farmers. All farmers interviewed had a high level of education which needs to be considered when interpreting the results. While "Animal Protection" appears as undisputed and of high importance to farmers, "Animal Welfare" is less understood and being considered as a more theoretical concept. The farmers generally assess the level of Animal Protection being high on their farms. This appears to derive from professional ethics and economic considerations. Social demands are deemed less relevant. Interviewed farmers presented themselves as considerate in all aspects of Animal Welfare and open to discussion on the pros and cons of modern dairy farming.

Keywords: Animal Welfare, Interview, Ethics.

Correlation between Welfare Quality® protocol and antibiotic usage in portuguese dairy farms

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Objectives: The objective of this study was to evaluate the relationship between animal welfare in ten dairy farms in Portugal with the use of critically or non-critically important antibiotics. We hypothesized that higher Welfare Quality® protocol (WQ) results, promote a reduction in the use of critically important and non-critically important antibiotics.

Methods and materials: Ten farms were used in this study and were visited between January and September 2021. Farm size ranged from 35 to 789 milking cows at the time of the visit. All animals were kept on an intensive-based free-stall production system with several diverse bedding choices and were milked twice a day, with with the exception of one farm where cows were milked three times a day. All farms were assessed for animal welfare using the WQ® protocol. Antibiotic use was obtained from the farms' treatment records, and only data from the year prior to the WQ audit was considered. General use of antibiotics was calculated using the Fifth OIE Annual Report on Antimicrobial Agents Intended for Use in Animals (OIE, 2021) guidelines. For each farm, animal biomass was calculated, only considering the WQ protocol sample as eligible. For each milking cow, an average weight of 450kg was considered. As for dried-up cows and heifers allocated together, a correlation of 0.8 of a milking cow was applied. Treatment records from the year prior to the farm visit were transferred into a Microsoft® Excel for Mac version 16.56 sheet, and antimicrobial use was flagged and separated into critically important antibiotic, if the active substance was from groups "A- Avoid" or "B- Restrict" of the Antimicrobial Advice Expert Group categorization; or non-critically important antibiotic, if the active substance was from groups "C- Caution" or "D- Prudence" of the Antimicrobial Advice Expert Group categorization (EMA, 2019). Finally, the Fifth OIE Annual Report on Antimicrobial Agents Intended for Use in Animals (OIE, 2021) adapted formula was applied to both critically and non-critically important antibiotics and correspondent productive biomass:

Antibiotic usage (mg/Kg)=Antimicrobial agents reported (mg)/Productive biomass (Kg).

The data was stored in a Microsoft® Excel for Mac version 16.56 sheet, and the descriptive statistical analysis and proposed correlations were calculated using RStudio® Mac version 2021.09, using Spearman's bivariate correlation with a significance level of 5% ($p < 0.05$).

Results: From the farms considered in the study, 80% obtained the "Enhanced" level, while 20% were classified as "Acceptable" as the final score. No farms were classified as "Excellent" or "Not Classified". Critically important antibiotics' use showed a tendency for a moderate negative correlation with the "Absence of disease" criteria ($p = 0.071$). The remaining correlations between critically importance antibiotics use and the WQ scores, showed no significance ($p ≥ 0.336$). Also, there were no significant correlations between non-critically important antibiotics use and the WQ scores.

Conclusions: Critically important antibiotics tended to be used less in farms with higher "Good Health" principle score. Our results show that welfare assessment protocols may be a way of identifying farms that overuse antibiotics.

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Keywords: Animal welfare, Welfare Quality®, Dairy cow, Critically important antibiotics, Non-critically important antibiotics

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CW-15

Adapting a New Zealand animal welfare assessment protocol for extensive beef systems in Namibia

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Objectives: Although beef production differs significantly between New Zealand and Namibia in terms of cattle management systems, topography and climate, both countries have extensive beef systems with a focus on exporting beef to lucrative markets. Thus, beef from both countries is expected to conform to the high animal welfare standards demanded by these markets. This is increasingly likely to require a formal assessment. However, simply transferring protocols developed for industrialized intensive systems to extensive systems is not appropriate. Assessment systems need to be developed for the system they are testing. We have recently created a specific welfare assessment for extensive pasture-based beef cattle in New Zealand using measures from Welfare Quality and the UC Davis Cow-Calf protocol, with additional New Zealand-specific measures. The aim of this study was to test this protocol on semi-desert rangeland-based beef cow-calf production systems in Namibia and adapt it to those conditions.

Material and Methods: The protocol was tested on 55 Namibia beef properties (17 commercial farms, 20 semi-commercial farming villages and 18 communal farming villages) in autumn (March to April). Cows were assessed in the yards during a pregnancy test (total 2459 cows) and at grazing. Stockmanship was evaluated by observing cow handling alongside yard design and facilities. A questionnaire guided interview with the fam manager was used to assess the health and management of cattle. Follow-up visits in winter evaluated changes in animal health, welfare and cattle management.

Results: We identified several issues that were not covered by the New Zealand-developed protocol, including compulsory cattle hot iron branding, ticks, flies, predation, snake bites, plant poisoning, and recurrent drought. There were also significant differences across the Namibian beef properties in the feasibility of applying the protocol. For commercial farms, the quality of the yards and the handling facilities were similar to those seen in New Zealand. In contrast, the facilities on the semi-commercial and communal properties were of a lower standard. This was exacerbated by the persistent drought that was present during the study period, which meant that cattle on semi-commercial and communal farms often had a long-distance to go grazing or water so were unavailable for assessment outside of very early morning. Additionally, many of those farms had cattle at temporary grazing sites where facilities were even poorer with yards made of thorn bushes and tree stumps and no separate pens. This resulted in difficult and protracted cattle handling which was accompanied by shouting and hitting from cattle handlers. Other welfare issues identified on semi-commercial and communal farms were the presence of horns on most cattle, and multiple brands and brand wounds.

A key part of the assessment is setting targets for welfare. For some assessment measures, there is an effect of the system on the likely welfare impact. For example, in spring, most New Zealand beef cows have watery feces. This is not a welfare issue. In contrast, similar levels of diarrhea in Namibian cows in spring would indicate a welfare problem. However, as much as possible, assessment should be consistent across systems and countries, with similar targets for similar conditions. For a cow, the welfare impact of a broken tail does not vary across systems, so why should the target vary between systems? Nevertheless, if systems are extremely different then targets may have to be modified. This is particularly apparent when comparing body condition (as an indicator of nutrition) between New Zealand and Namibian beef cattle. The drought meant that more than 40% of cows on communal farms were classified as emaciated, levels which would result in prosecution on New Zealand farms. Setting body condition score targets for Namibian farms based on New Zealand targets is not going to be appropriate, but if the targets are made too easy then they are no longer useful for meeting the welfare

demands of overseas consumers.

Conclusion: This study is the first integral step towards developing welfare assessment and monitoring scheme for beef cattle in extensive semi-desert rangeland management such as those in Namibia, with the aim of developing an assessment which will be useful for both export purposes and improving the animal welfare standards on Namibian beef farms.

Keywords: Welfare assessment, beef cattle, New Zealand, Namibia.

CW-16

Heat stress in a temperate climate leads to adapted sensor based behavioral patterns of dairy cows

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Most research on heat stress has focused on (sub)tropical climates. The effects of higher ambient temperatures on the daily behavior of dairy cows in a maritime and temperate climate are less well studied. With this retrospective observational study, we address that gap by associating the daily time budgets of dairy cows in the Netherlands with daily temperature and temperature humidity index (THI) variables.

During a period of four years, cows on eight commercial dairy farms in the Netherlands were equipped with a neck and leg sensors to collect data from 4345 cow lactations regarding their daily time budget. The time spent eating, ruminating, lying, standing and walking was recorded. Individual cow data was divided into three datasets: 1) lactating cows from five farms with a conventional milking system (CMS) and pasture access, 2) lactating cows from three farms with an automatic milking system (AMS) without pasture access, and 3) dry cows from all eight farms.

Hourly environment temperature and relative humidity data from the nearest weather station of the Dutch National Weather Service (KNMI) was used for THI calculation for each farm. Based on heat stress thresholds from previous studies, daily mean temperatures were grouped into seven categories: 0 (< 0°C), 1 (0-12°C, reference category), 2 (12-16°C), 3 (16-20°C), 4 (20-24°C), 5 (24-28°C) and 6 (≥ 28°C); THI values were grouped as follows: 0 (THI < 30), 1 (THI 30- 56, reference category), 2 (THI 56-60), 3 (THI 60-64), 4 (THI 64-68), 5 (THI 68-72) and 6 (THI ≥ 72). To associate daily mean temperature and THI with sensor based behavioral parameters of dry cows and of lactating cows from AMS and CMS farms, generalized linear mixed models were used. In addition, associations between sensor data and other climate variables such as daily maximum and minimum temperature and THI were analyzed.

On the warmest days, eating time in the CMS group decreased by 92 min/day, in the AMS group by 87 min/day and in the dry group by 75 min/day compared to the reference category. Lying time in the CMS group decreased by 36 min/

day, in the AMS group by 56 min/day, and in the dry group by 33 min/day. Adaptation to daily temperature and THI was already noticeable from a mean temperature of 12°C or a mean THI of 56, above, when dairy cows started spending less time lying and eating and spent more time standing. Further, rumination time showed a decrease, though only in dry cows and cows on AMS farms. With higher values for daily mean THI and temperature, walking time decreased as well. These patterns were very similar for temperature and THI variables.

These results show that dairy cows in temperate climates begin to adapt their behavior at a relatively low mean environmental temperature or THI. In the temperate maritime climate of the Netherlands, they indicate that daily mean temperature suffices to study the effects of behavioral adaptation to heat stress in dairy cows.

Keywords: Dairy cow, heat stress, sensor data, time budget.

CW-17

Sensor based continuous heart rate monitoring in calves to evaluate stress induced by different sampling techniques of the respiratory tract

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Objectives: In recent years samples of the respiratory tract are more frequently taken to rationalize antimicrobial use. It is currently unknown how stressful or painful these techniques are and whether differences exist between commonly used methods like deep nasopharyngeal swabbing (DNS), non-endoscopic bronchoalveolar lavage (nBAL) or transtracheal wash (TTW). Heart rate monitoring holds potential as a precision livestock farming application for evaluation of production efficiency and animal welfare (detection of stress, pain and (positive) excitement). Sensor-based heart rate monitoring is largely unexplored in calves. Therefore, the objective of this study was to compare the effects of DNS, nBAL and TTW on parameters derived from sensor-based continuous heart rate measurements in relation to resting heart rate and changes associated with feeding. Additionally, behavior, cortisol and substance P were determined.

Materials and Methods: A crossover study was conducted under experimental conditions, including 5 male Holstein-Friesian calves. Inclusion criteria were absence of pneumonia by thoracic ultrasonography and no failure of passive transfer. During the study the calves were individually housed in a straw-bedded pen, each with an individual top view camera. Each calf was equipped with a sensor (Movesense, Vantaa, Finland), which transmitted to a self-developed gateway (ESP-32) in the top view camera, attached to a chest strap. The sensor continuously collected heart rate measurements.

Data was transferred when a change in heart rate was noticed (inherent to the sensor software). Five sessions were organized, and calves were randomly assigned to one of the 5 test groups (negative control, only fixation for 2 minutes, DNS sampling, nBAL sampling, TTW sampling).

Pain scoring was done according to the pain face checklist by an examiner at -2h, +3h, +7h, +22h and +27h relative to the respiratory tract sampling. A permanent catheter was placed in the jugular vein and blood samples were collected at -1h, 0h, +1h, +5h and +24h relative to the sampling.

Heart rate data were filtered using a Savitzky-Golayfilter and different variables were calculated for analysis being, mean heart rate, area under the curve of the handling ($AUC_{handling}$), AUC of the handling/time (corrected for the length of the handling), the triangular index and the LF/HF ratio (Low frequency power (LF)/High frequency power (HF)) . Resting heart rate was defined as the mean heart rate outside feeding or handling procedures. By visual inspection the length of the 'event', being the positive deviation from resting heart rate, was determined. Similarly, the AUC of the event (AUC_{event}) and the AUC/time of the event were calculated. Analysis was done by linear mixed models in R. Additionally, behavior, cortisol and substance P were determined.

Results: Resting heart rate, was 98.39 beats per minute (bpm) (standard deviation (SD)=25.0; quantile (q) (0.02)=63.0; q(0.98)=158.1). The average of DNS, nBAL and TTW sampling was 124.6 bpm (SD=25.5; q(0.02)=87.6; q(0.98)=171.9), 115.6 bpm (SD=16.5; q(0.02)=81.2; q(0.98)=144.7), and 108.5 bpm (SD=19.7; q(0.02)=74.4; q(0,98)=167.6), respectively. Mean heart rate during the handling procedure was 111.7 bpm (SD=18.4; q(0.02)=81.8; q(0.98)=165.9), whereas this was 142.1 bpm (SD=26,9; q(0.02)=92.2; q(0.98)=191.4) during feeding. The LF/HF ratio during feeding was significantly ($P<0.05$) higher than all of the sampling techniques. LF/HF was significantly larger in DNS sampling compared to control, nBAL and fixation ($P<0.05$). The triangular index was significantly higher in feeding events compared to control and all sampling procedures ($P<0.05$), but no differences between sampling procedures could be shown. There were no significant differences between the sampling procedures in any of the other heart rate variables studied. Mean heart rate was significantly lower in the last two sessions compared to the first one, which is likely an age or habituation effect.

Conclusions: The presented sensor system provided continuous and reliable heart rate measurements in calves. In this study, LF/HF ratio was the most promising parameter for non-invasive stress-evaluation in calves. Calves appeared to cope reasonably well with respiratory sampling techniques when compared to feeding events. Based on the LF/HF ratio, DNS sampling would be more stressful compared to the other methods. Confirmation of current findings on more animals and further evaluation of stress and pain induction by sampling methods by behavioral monitoring and blood analysis needs to be done.

Keywords: Heart rate variability, LF/HF ratio, Deep nasopharyngeal swabbing, Non-endoscopic bronchoalveolar lavage.

Qualitative Analysis of working employees' motivation and satisfaction on two large dairy farms

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Objectives: As dairy herds continue to grow in size globally, employees play an increasingly important role: Their motivation and satisfaction are crucial factors in animal welfare and production. The specific demands in terms of work flow, hours working and the proximity to animals seems to make it increasingly difficult for dairy farms to recruit personnel. A competition among farms for personnel is frequently observed. As there is little information on the role of employees in relation to animal welfare and health, information on factors relevant for the motivation and satisfaction of personnel were to be collected. It was to be determined whether factors creating satisfaction (Hygiene factors) and motivation (Motivators) were discernible. The role of the animals in work satisfaction and motivation was to be analysed.

Material & Methods: The dairy farms chosen for this study had a herd size of 1300 and 750 cows, respectively. 17 employees of the farms were interviewed using a semi structured interview. The interviews were transcribed, encoded and analysed for relevant information concerning the status quo of satisfaction and motivation. Categories of relevant information were formed and summarized.

Results: Various factors affected individual motivation and satisfaction of employees. As positive factors were identified intrinsic motivation to work within a team, as well as organization of work and holiday by the farm management. Working with animals was positive for most employees. Negative factors were failure of farm equipment, animal health problems and little recognition of achievements by the respective superior. There was little intrinsic motivation recognisable towards actively improving the animal welfare and health situation.

Conclusion: The 17 semi-structured interviews can serve as an example for the attitude of personnel working on large dairy farms, the results must however not be generalized. While animal-related factors incite a sense of responsibility and working with them created satisfaction, there was little motivation in employees to actively improve the situation if deficits were recognized. Such deficits were nevertheless identified as creating dissatisfaction among employees. Unspecific factors such as working environment, colleagues and organization of working hours were regularly mentioned as source of dissatisfaction. It was not possible to clearly differentiate between hygiene factors and motivators, respectively. The status quo was identified as being either a state of "pseudo-satisfaction" or "fixed dissatisfaction". Further research on the role of employees seems to be necessary. On the farms surveyed, the staff felt responsible for the animals but did not feel able to change deficits by themselves. This may be interpreted as a cognitive dissonance which may further deteriorate motivation of the staff. The method of qualitative analysis was appropriate to understand the situation of farm personnel.

CW-20

Relation between hair-cortisol concentration and welfare assessment protocols in dairy cows

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Objectives: Several protocols have been developed to assess farm animal welfare. However, the validity of these protocols is still subject to debate. The present study aimed to validate and compare eight welfare assessment protocols for dairy farms. Long term stress has a negative influence on animal welfare. Because the hair cortisol level is related to stress over a long period of time, a negative correlation between cortisol and the result of the welfare protocol scores was expected.

Material & Methods: On 58 dairy farms, spread over the Netherlands, the following assessment protocols were applied: Welfare Quality©; a modified version of Welfare Quality; KoeKompas (= Cow Compass); WelzijnsWijzer (=Welfare Indicator); a new Welfare Monitor; Continue Welzijns Monitor (Continuous Welfare Monitor); Cow Comfort Scoring System and the Welfare Index. On each farm, hair was collected from 10 cows to measure cortisol concentrations. Correlation coefficients were calculated between each of the welfare assessment protocol scores and mean hair cortisol concentrations.

Results: Only Koekompas (ρ = -0.23) and a simple welfare estimation by veterinarians (ρ = -0.28) had a weak, but significant, negative correlation with hair cortisol. Additionally, the modified Welfare Quality® protocol parameters housing (ρ = -0.30), the new Welfare Monitor parameter health (ρ = -0.33), and milk yield (ρ = -0.33) showed non-significant negative correlations with cortisol.

Conclusion: Because only five out of all the parameter scores from the welfare assessment protocols showed a negative correlation with cortisol, the protocols might not be reliable or, alternatively, hair cortisol levels may not be a valid indicator for stress in dairy cattle.

Keywords: Welfare assessment, cortisol, stress.

CW-21

Herd-level risk factors for calf and cow mortality in Estonian dairy herds

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Objectives: On-farm mortality (unassisted death and euthanasia) is an unwanted loss of an animal which negatively affects farm economy. On-farm mortality rates reflect animal welfare status and high rates indicate deteriorated animal health. The objective of this study was to determine the associations between herd characteristics, animal housing conditions and management routines and within-herd calf and cow mortality rates in Estonian dairy herds.

Material and methods: The study population included all dairy farms enrolled in the Estonian voluntary production recording system with herd size of ≥20 cow-years in 2015-2017. A questionnaire was developed to collect data about management routines and housing conditions of calves and cows. The 338 farmers fulfilling the inclusion criteria were contacted by mail or telephone between October 2017 and March 2018. In total, 214 completed questionnaires were gathered. The within-in-herd mortality rates of calves (21-90 days) and cows (over 24 months) in years 2017-2018 were calculated and used as outcome variables. Negative binomial and linear regression models were applied for risk factor analysis in calf and cow datasets, respectively.

Results: The final datasets for calves and cows included 212 farms (usable response rate was 62.7%). The median within-herd mortality rate for calves aged 21-90 days was 0.15 per 100 calf-months (quartiles 0.00; 0.36). The median within-herd mortality rate for cattle over 24 months of age was 4.57 per 100 cow-years (quartiles 2.44; 6.86). Factors significantly associated with the increase of mortality of calves were larger herd size (p = 0.005), higher proportion of stillbirths and abortions (p < 0.001), prophylactic administration of vitamins to all calves (p = 0.041) and housing pre-weaned calves in single pens only compared to housing in both single and group pens (p = 0.020). Also, farmers that attended trainings more frequently had higher calf mortality rates (p = 0.008). Having calvings only in group pens or tie-stalls compared to multiple places was associated with higher calf mortality rates (p = 0.020). Higher cow mortality rates were present in farms where employees handled cows (p < 0.001). Also, farms located in the North-East part of Estonia had higher calf (p = 0.020) and cow (p < 0.001) mortality rates. Housing cows in freestall barns (p = 0.008), grazing cows (p = 0.006) and more frequent hoof trimming (p = 0.002) reduced within-herd cow mortality rates.

Conclusions: On-farm mortality rates in Estonian dairy herds are similar to what has been reported in other countries. Still, a high between-herd variability in on-farm mortality rates in calves and cows was confirmed. Study results suggest that housing conditions have impact on the health and welfare of dairy cattle. Providing more natural keeping conditions to cows (freestall housing, grazing), mitigating important herd health problems (lameness, reproduction health) and motivating farm personnel could be considered as key factors in achieving improvements in on-farm mortality rates.

Keywords: Dairy cattle, euthanasia, mortality, unassisted death, housing conditions.

CW-22

Evaluation of the association between health status and other risk factors and low sale price in Québec veal calf markets

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Objectives: The first objective of this study was to evaluate health status of young calves sold in the two largest Québec auction markets. The second objective was to assess which individual characteristic had an impact on the calf's sale price.

Materials and methods: A cross-sectional study was conducted during in "month" of 2019 in two auction markets in Québec, Canada. Calves' health was assessed upon arrival using umbilical characteristics (presence of umbilical cord, dampness, swelling, and pain). Presence of sunken eye and positive skin tent test, nasal and ocular discharge, lameness, dropped ears was also evaluated. Evaluation of body score and hide cleanliness was recorded.

A study was performed to assess individual characteristics associated with a low sales price per kg. Calves sold with a price under 10th percentile of the day were considered as cases and calves sold more than 50th percentile were considered as controls.

Results: A total of 1 871 calves were enrolled in the study. Of these, 81.8% were males. The majority were Holstein (76.0%), 15.7% were Angus crossbreed, 4.3% were other beef crossbreeds, and 4.0% were non-Holstein dairy breed.

Umbilical cord was present in 39.7% of calves. Wet umbilicus was present in 4.4% of calves. Umbilical swelling was observed in 17.5% calves. A total of 5.7% of calves were painful during umbilical palpation. Sunken eyes and skin stent greater than 2 sec. were present in 14.0% and 22.7% of calves, respectively. Ocular discharge was present in 41.5%, and nasal discharge observed in 0.1% of calves. Lameness was present in 0.5% of calves. Body condition was considered low in 4.6% of calves. Dirty hide was observed in 14.1% of calves. Diarrhea was observed in 2.6% of calves. Dropped ears were noted in 0.9% of calves.

The odds ratios to be a case were significantly higher for non-Holstein dairy breeds versus Holstein (OR=12.5, 95% CI 5.5-33.3), female calves (OR=4.6, 95% CI 3.2- 6.9), calves having a poor body condition (OR=9.1, 95% CI 16.6-4.50), calves presenting sunken eye (OR=2.1, 95% CI 1.4-3.2) or having a skin stent greater than 2 sec. (OR=1.9, 95% CI 1.3-2.7) and calves presenting dropped ears (OR=3.57, 95% CI 1.77-11.1).

Conclusion: The most frequent abnormal clinical signs observed in this study are related to the umbilicus and hydration status. Breed, sex and some clinical signs appears to impact the sales price in calves sold at auction market.

Future studies could aim to better understand if these anomalies are present before leaving the farm of origin or are occurring during transportation from the farm to the auction market.

CW-23

Pain detection of cows with mastitis in the barn and at milking: a piece of cake?

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Objectives: Pain is one of the most detrimental factors affecting dairy cows' welfare, and induces production losses. Mastitis is a good model for pain research in cattle, as it is a commonly occurring inflammatory painful disease. When induced by LPS infusion in the udder, mastitis has a limited duration, and non-steroidal anti-inflammatory drugs (NSAIDs) can easily modulate it. To date, there is a lack of knowledge on the behavioral reaction of mastitic cows in cubicles and at milking. This study aimed at refining behavioral indicators of pain in dairy cows with mastitis, according to time and whether cows were observed in the cubicle barn or at milking.

Materials & Methods: Twenty-seven cows received an intra-mammary infusion of 25 µg E. coli LPS in one healthy quarter. Thirteen cows received 3 mg / kg ketoprofen IM (Ketofen® 10%) in addition to LPS (LPS+NSAID cows), and 14 cows received placebo (20mL NaCl 0.9% IM) instead of NSAID (LPS cows). Evolution of the local immune response was assessed using somatic cell counts (SCC) and cytokines/chemokines quantification. Cows' response to the challenge was monitored at regular intervals from 24 hours before to 48 hours post-infusion (hpi) through direct clinical observations (cardiac, ruminal and respiratory frequencies), through indicators of inflammation (in milk: cytokines/chemokines, haptoglobin, serum Amyloid A (SAA)) and stress (cortisol in blood and in milk), and through direct behavioral observations in the barn (i.e. postures, activity, social behavior, ear positions, etc.) and at milking (i.e. steps, lifts, kicks).

Results: In LPS cows, infusion induced significant changes of endocrinal, inflammatory and clinical parameters. Blood cortisol peaked at (mean [95% IC]) 69.18 [48.98-97.72] ng/ml at 3 hpi and remained above 65 ng/ml at 7 hpi. Milk cortisol peaked at 1.69 [1-3.01] ng/ml at 7hpi. SCC peaked at 1.8 x 10^7 cells/ml at 7 hpi and remained above 8 x 10^6 cells/ml until 48 hpi. IL-6, IL-1b and CXCL8 peaked at 7 hpi (respectively: 1.9 [1.7-3.0] x 10^3 nmg/ml; 1.6 [0.7-2.3] x 10^2 ng/ml; 2.7 [1.7-7.0] x 10^3 ng/ml). SAA in milk significantly increased at 7 hpi, 24 hpi, 31 hpi and peaked at 7.4 [4.5-12.8] x 10^4 ng/ml) 48 hpi. More LPS cows stopped feeding/ruminating and pressed their tail between their legs at 3, 5, and 24 hpi than before (P < 0.05 in all cases). They also tend to be more numerous to

be apathetic, dropping their head and dropping their ears at 5 hpi (P = 0.07 in all cases). At milking, significantly more LPS cows were lift their hooves at forestripping at 7 hpi than before (P=0.04.

LPS+NSAID and LPS cows showed similar pattern of responses for milk cortisol, SCC, respiratory rate, mAA, haptoglobin, IL-6, IL-1b and CXCL8 (P > 0.05). Compared to LPS cows, LPS+NSAID cows had significantly lower plasmatic cortisol levels at 3 hpi (61.66 [24.57-144.54] ng/ml). At 7 hpi, compared to LPS cows, LPS+NSAIDs cows' rectal temperature decreased by 0.66 [(-0.85)-(-0.48)] °C, their rumen motility rate increased by 1.04 [0.34-1.75] contraction/min. At 31 hpi, compared to LPS cows, LPS+NSAID cows' heart rate increased by 8.44 [1.00-15.91] beats/min, and their rumen motility rate increased by 0.89 [0.19-1.60] contraction/min. Compared to LPS cows, a larger proportion of LPS+NSAID cows were feeding or ruminating (P = 0.02), and few of them had ears down (P = 0.04) at 5 hpi; they were more numerous to lie down at 24 hpi (P = 0.02).

Conclusion: This study confirms the benefits to use behavioral indicators to early detect pain associated with mastitis in dairy cows, particularly during milking. These behavioral indicators (feeding/ruminating, tail position, reactivity at forestripping) could be useful for early detection of mastitis and for decision-making regarding the initiation of pain-relief treatment during mastitis in dairy cows. This will contribute to animal welfare improvement.

Keywords: Dairy cow, Pain, Behaviour, Welfare, Detection.

CW-24

First approach to monitoring animal welfare with Precision Farming devices during fattening

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Objectives: Consumers´ concerns about animal welfare are continuously increasing and are consider one of the main sustainability drivers for animal production systems today and in the future. This study focuses on the possibilities of monitoring some animal welfare parameters, such as ruminating, feeding and resting time, using precision farming (PF) technology. The final objective of this work is to help farmers to adapt their facilities and handling protocols to improve animal welfare based on the objective data obtained with the PF devices.

Materials and methods: Four one year old fattening crossbred animals, from a commercial beef cattle farm in Salamanca were monitored throughout the last 30 days of the fattening period. Two electronic devices for monitoring variables of interest were used. On one hand, electronic eartags, with three dimensional accelerometer that allows determining animal's activity patterns, were used. Specifically, time spent eating, ruminating, and resting were measured every 60 minutes. On the other hand, ruminal bolus with pH and temperature sensors that records data every 10 minutes were also used.

Two samples of hair were obtained from the suprascapular region of each animal following the methodology recommended in the revised literature in order to use hair cortisol concentration (HCC) value as indicator of chronic stress. This assessment technique made it possible to have an objective stress measures. Determination based on difference in the initial and the final HCC during fattening period was carried out using competitive ELISA (kit ELISA cortisol Neogen 402710) in the physical-chemical laboratory of the Estación Tecnológica de la Carne (ITACyL). All data has been statistically analyzed with RStudio software. Interactions among variables were assessed by Pearson's correlation coefficient. Analysis of variance (ANOVA) was used to evaluate the significance of deviation between animals.

Results: The result showed a mean cortisol increase of 0.83 ± 1.93 ng/g and a pH and temperature average of 6,68 ± 0,37 and 39.75 ± 0.098 °C, respectively. Mean rest time was 22.08 ± 0.41 min/hour. The mean rumination time was 21.98 min/hour with a standard error of 2.92 min/hour. Mean intake time per hour was 5.92 ± 1.87 min/hour.

This study reported a significant association between some animal welfare parameters. Elevated cortisol levels were associated with high temperatures (0.96). Temperature variations could be due to increased fermentation activity. Long rest times were related to a decrease in hair cortisol concentration (-0.89). Therefore, it is essential that the dimensions and characteristics of farm facilities allow all animals to rest. Lower pH values were associated with increases in cortisol levels (-0.61). A balanced diet maintains a stable pH, this improves animal welfare. Hence, it's important to use feed made with suitable formulas that prevent digestive pathologies. Positive effects of rest times on pH (0.88) and negative correlation with temperature (-0.88) were reported. Intake times were inversely related to ruminal pH (-0.99).

A pH below 6 maintained for 1430 minutes/day corresponded with the highest cortisol level (6.8 ng/g). Also, the same animal presented the lowest pH (4.95). In contrast, the animal with the shortest time (370 min/day) with a pH below 6 showed one of the lowest levels of cortisol (2.32 ng/g).

Conclusions: Based on the presented results it can be stated that several monitorable parameters can be used to improve animal management during the fattening period, thus animal welfare is enhanced. Finally, studies on the effect of cortisol concentration, temperature, ruminal pH, rest time, intake time and rumination time on animal welfare are needed to evaluate current recommendations.

Keywords: Welfare, precision farming, hair cortisol, ruminal pH.

CW-25

Fly repellency effect of deltamethrin improves stress and fatigue indicators and increases feed consumption of pre-weaned dairy calves, exposed to heat stress conditions

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Objectives: The objective of the study was to assess the fly-repellency effect of deltamethrin on pre-weaned dairy calves and to quantify its association with serum cortisol (SC) and creatine kinase (CK) concentrations as well as with feed consumption in pre-weaned dairy calves, under heat stress conditions.

Materials and Methods: Two intensively reared dairy cattle herds of Holstein breed located at Thessaloniki (Central Macedonia, Greece) were involved in the study between July and August 2020. Fifty calves per farm were assigned in two similar groups (n=25 per group) according to their age and gender; deltamethrin treated group (D group) and placebo treated group (C group). In all cases, 10 mL of deltamethrin (Deltanil® 10 mg/mL, Virbac Hellas, Greece) was applied once on pre-weaned dairy calves at the age of 15 days old. The enumeration of the fly burden was carried out by direct observation of the animals every 10 days at the ages of 25, 35, 45 and 55 days to assess the repellency effect of deltamethrin until weaning. Moreover, 10 fly traps (5 per group) with sticky surface were set in each farm, in predefined locations, of equal distances within the pens at the level of the calves. Blood samples, from each calf, were collected at the forementioned time points and were transported to the laboratory to be further assayed. The estimation of SC concentration was performed with electrochemiluminescence immunoassay method and CK concentration was estimated using spectrophotometry. Daily consumption of concentrates and roughages were estimated per calf and calculated by subtracting daily refusals from the offered amount. Temperature-humidity index (THI) was used to describe severity of heat stress the studied calves experienced. The differences of the meteorological data were estimated with the chi-square test. Inverse Gaussian regression models were used to estimate the random effect of the sth calf and the fixed effects of deltamethrin treatment, the sampling occasion, and the farm on the SC and CK levels, flies' number, and daily consumption of concentrates and roughages. All statistical analyses were performed using SPSS (v23).

Results: THI ranged from 94 to 96 throughout the study, without statistically significant variations among sampling occasions, indicating that all pre-weaned calves experienced similar heat stress conditions. In group D, the number of flies landing on calves was reduced by 60.6 flies (p<0.001) in comparison to group C. In group D, SC and CK concentrations were reduced by 1.86 µg/dL (p<0.001) and 1101 nkat/L (p<0.001) when compared to group C. Regarding the feedstuff consumption, in group D calves the concentrates and rough-

ages' consumption was increased by 137 g/day (p<0.001) and 25 g/day (p<0.001), respectively compared to group C.

Conclusions: Fly infestation challenges health and welfare of pre-weaned dairy calves, creating unfavorable living conditions. Heat stress further deteriorates these living conditions, leading to stressful conditions resulting in increased SC and CK and decreased feed consumption, therefore consisting possible stress and fatigue indicators. Deltamethrin treatment decreased the number of flies landed on pre-weaned dairy calves, improved SC and CK level and was associated with increased feed consumption under heat stress conditions, which characterize Greek summer months.

Keywords: Feed consumption, houseflies, pre-ruminants, fly-repellent; temperature-humidity index.

CW-26

Structural equation modeling to assess farm level welfare estimations

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Objectives: Structural equation models (SEM) are widely used to estimate the magnitude of latent variables, which cannot be measured directly. It is widely used in psychology, social sciences and quality of life assessments in humans. There are many reports using SEM to estimate animal welfare related attitudes in people, but I was not able to find any papers applying SEM to evaluate animal welfare as itself.

I aimed to study animal welfare of Finnish bulls based on data from the Finnish national herd health scheme NASEVA and the suitability of SEM for development of NASEVA as a welfare measure.

Materials and methods: NASEVA is an industry-financed herd health tool for Finnish cattle farmers and veterinarians. It includes modified, partially Welfare Quality -based animal health and welfare estimations on annual farm visits performed by local veterinarians. There are altogether 2 indicators scoring housing, outdoor visits, nutrition, health, behavior and biosecurity from "good" (1) to "action needed" (3). All indicators scoring housing were used to calculate a housing index, which was assigned to be 1 if all indicators were 1 and 0 if all indicators were 3.

Atria is the biggest slaughterhouse in Finland. There are detailed animal level records available for every slaughtered animal. I selected all 253 farms slaughtering over 50 dairy breed bulls with available NASEVA data.

SEM was used to find the best predictors and indicators for welfare in finishing beef farms in Finland. Housing index, nutrition and health indicators in NASEVA and other farm descriptors were used to find significant causes for latent welfare variables, which in turn were determined by observed welfare indicators in slaughter records and on welfare visits. Predicted values were compared with observed values to estimate the model fit.

Scenarios describing relationships between significant predictive variables, found latent variables and significant welfare indicators were built to be able to explore the found associations in practice.

Results: It was possible to determine two separate significantly co-varying latent indicators describing animal welfare: 1) "Risk for impaired welfare" was found to be indicated by the number of culled animals, the number of bruises in meat inspection, cleanliness of animals and the number of fatty carcasses as well as animal behavior, lameness and lesion scores on welfare visits; 2)"Growth ability" was found to be indicated by the number of fatty carcasses, estimated daily gain and carcass grade score at the slaughter. However, Indicator variables did not reveal a latent variable describing animal welfare determined as feelings.

Housing index and farm size were found to be significantly positively associated with "Growth ability" and the number of bruises in meat inspection. Housing index was negatively associated with "Risk for impaired welfare", but positively associated with the number of culled animals and the number of dirty animals at the slaughter. Farm size was positively associated with "Risk for impaired welfare" and "Growth ability".

"Growth ability" was doubled, and "Risk for impaired welfare" halved when housing index was changing from the worst to the best. Housing index had a remarkable association with used welfare indicators as well: for example, the proportion of good classifications for behavior increased from 60% up to 100% when housing index was changing from the worst to the best.

Conclusions: SEM was found to be a suitable and practical tool to evaluate animal welfare and animal welfare estimation protocols on commercial farms. It gives a well structuralized picture of on-farm welfare.

NASEVA was found to be a valid tool for animal welfare estimation. It allowed a formation of two separate latent variables describing existing animal welfare on Finnish beef farms. "Risk for impaired welfare" is associated with various health and welfare deteriorations, whereas "Growth ability" is predicting high daily gain, carcass fat and grade scores. Adding qualitative behavioral assessment protocol in NASEVA could possibly enable the measurement of animal welfare determined by feelings.

Keywords: Welfare, bull, housing, growth, bruises.

Effects of xylazine administration prior to laparoscopic abomasopexy as described by Janowitz on cortisol, substance P, and behavior in cattle

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Objectives: Left displacement of the abomasum (LDA) is a disease diagnosed in cattle all over the world, causing huge economic losses. Fixation of the abomasum by laparoscopic abomasopexy (LA) has first been descrribed in 1998 by Janowitz. Usually, cattle are not sedated due to the risk of them going down. Studies showed that concentrations of cortisol, and indicator for stress, fear, and pain in cattle, are reduced in animals treated with xylazine prior to being put into lateral recumbency with a tilt table, compared with untreated animals. The objective of this study was to evaluate cortisol and substance P concentrations in cattle undergoing LA after administration of xylazine, compared with a control group, and to describe behavioral observations and feeding and rumination time.

Material and Methods: LA was performed in 28 cows (aged 6.0 ± 2.0 years) with LDA, accodring to a standardized surgical protocol. Cows were randomly assigned to either CON (control group, n = 14) or XYL (xylazine treated group, n = 14). All cows were treated with 10 liters of 0.9% saline and 1 or 2 liters of 40% glucose on the day before surgery, benzyl penicillin procaine (20.000 IU/kg bodyweight intramuscularly) from the day before surgery for 4.89 ± 1.26 days, and ketoprofen (3 mg/kg bodyweight intravenously) on the day of the surgery and the following day. Cows of XYL received xylazine (2 mg/kg bodyweight intravenously) at the start of the surgery. Animals of CON received a placebo (0.9% sodium chloride solution intravenously). Blood samples for determination of plasma cortisol (PCC) and plasma substance P concentrations (PSPC) and blood gas samples were taken 3 hours before surgery (baseline, +00:00 hours), at 11:00 am (start of the surgery, +03:00) and at +03:15, +03:30, +03:45 (dorsal recumbency), +04:00 (cow standing again, end of surgery), +04:40, +05:00, +06:00, and +27:00. Behavior of the animals was assessed on the day of the surgery and the following day at 08:00 am, 01:00 pm, and 05:00 pm, and during the surgery. Feeding and rumination time was recorded for 24 hours following surgery. Parameters were studied using a multiple linear mixed effects model.

Results: LA could be performed without any animal going down due to the sedation. Mean PCC were lower in XYL than in CON at all times. In CON, PCC increased after the start of the surgery, with highest concentrations at +04:00. In XYL, PCC decreased after the administration of xylazine, until +03:45, when animals were put into dorsal recumbency. In XYL, PCC were significantly lower compared with CON at +03:30 ($p = 0.03$). Compared with +03:00, PCC were significantly higher at +03:45 ($p \leq 0.01$), +04:00 ($p \leq 0.01$), and +04:30 ($p \leq 0.01$) in CON, and significantly lower at +03:15 ($p = 0.02$) and +03:30 ($p \leq 0.01$), and significantly higher at +04:00 ($p \leq 0.01$) and +04:30 $p \leq 0.01$ in XYL. PSPC did not differ significantly between or within groups. Glucose levels were significantly lower in CON compared with XYL at +03:45 ($p = 0.03$) and +04:30 ($p = 0.03$). Mean pCO_2 was significantly higher in XYL compared with CON at +03:30 ($p = 0.05$). In XYL, mean pCO_2 was significantly higher at +03:15 ($p \leq 0.01$), +03:30 ($p \leq 0.01$), +03:45 ($p \leq 0.01$), and +04:30 ($p = 0.01$) compared with +03:00. Compared with +03:00, pO2 was significantly lower at +03:45 ($p < 0.01$) and +04:00 ($p < 0.01$) in CON, and at +03:45 ($p < 0.01$) and +04:30 ($p = 0.04$) in XYL. Behavior did not differ significantly between groups during and after the surgery. In XYL, animals had significantly

higher number of chews per bolus (p = 0.02) over a period of 24 hours after surgery.

Conclusions: The results of this study show that PCC increase during LA, and that administration of xylazine results in significantly lower PCC during the course of the surgery, representing less stress for the animals. Thus, in the opinion of the authors, xylazine should be given in a low dose prior to LA to decrease the stress level. The application of xylazine before LA improves the welfare of cattle during and after a surgery even if it is thought to be a minor invasive surgery like the LA.

Keywords: Dairy cow, left abomasal displacement, pain, surgery, stress.

CW-28

First approach to develop an animal welfare assessment model for extensive suckler beef cattle sector

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Objectives: The increasing change in consumer preferences about the productive orientation both in animal and vegetable systems made it necessary a 180 degree change in the trends that prevailed until the beginning of the 21st century. There is an evolution from a system focused on productivity to a model that considers the one health concept with the environmental and animal welfare (AW) as important aspects of the sustainability of animal production.

In this scenario, it is necessary to protect and give additional value to productive models that meet consumers´ demands in terms of AW with additional environmental benefits. Our principal objective was to contribute to the sustainability of the extensive suckler beef cattle sector by developing a model to characterize AW of this type of farms in northwestern Spain.

Material and Methods: A model of AW characterization and assessment was developed based on the five freedoms used at present in the definition of AW of the Word Organization for Animal Health (OIE). Each one of them (freedom from hunger and thirst or adequate nutrition, freedom from discomfort or physical and thermal comfort, freedom from pain, injury or disease or health and absence of pain, freedom to express normal behavior or appropriate and natural behavior and freedom from fear and distress or absence of fear and anguish) have been evaluated using different parameters, based on the international bibliography and agreed with farmers. Some of those parameters were evaluated individually such as body condition score, ruminal fill score, locomotion scoring, hygiene scores, but others were considered at group level, the temperature and humidity index (THI) among them. All parameters were considered on a scale of 1 to 5, with 1 being the value indicative of a situation of very poor AW and 5 value of the best possible situation. Each freedom accounts to a maximum of 20 points.

On eighteen farms, 6 from Asturias and León, 6 from Extremadura and from 6 from Salamanca, with a total number of suckler cows ranging from 40 to 120 per farm, a representative number of adult cows in each farm were evaluated based on the MIL-STD-105D.

Results: Mean values of freedom 1 ranges from 17.6 ± 1.16 on Asturias and León farms to 18.4 ± 0.83 in Extremadura without significant differences in scores on the freedom 1 or adequate nutritional assessment. There were significant differences in freedoms 2, 3 and 4 ($F_{(2,15)}= 22.63612$ p= 0.000029, $F_{(2,15)}= 49.27239$ p= 0.000000, $F_{(2,15)}= 25.86748$ p= 0.000014, respectively). Freedom from discomfort (2) significant highest values were obtained in Salamanca (19.9 ± 0.31) and Extremadura (19.7 ± 0.19) possible due to the influence of mild climatological conditions compared with the Cornisa Cantábrica. Similar significant differences were registered in freedom 3 (health state and absence of pain), with lower values in Asturias and León farms (18.8 ± 0.25). In some of these farms adult cows spend 2 to 3 months in tied stalls during winter period and this could have a negative influence of parameters such as lameness score or mastitis incidence. The shorter duration of suckling period in Extremadura farms (3 months) could be responsible for the significant mean lower value of freedom 4 (16.3 ± 0.47) compared with León and Asturias (18.3 ± 0.87) and Salamanca (18.8 ± 0.54) farms.

Taking into account that mean total points were 91.1 ± 2.49 the AW of the studied suckling cows could be consider excellent. The extensive conditions of this production systems could have a negative influence on the fear from human expressed as higher approach distance but the moths expended on pasture or the possibility to feed their own calf could positively influence the suckler cows' welfare.

Conclusion: The model used in this first approach could be a useful tool to assess AW in cows keep under extensive production systems providing valuable information to consumers and this could help farmers to achieve a better market position for their product contributing thus to its sustainability.

Keywords: Welfare, assessment, suckler, sustainability.

CW-29

Correlation between Welfare Quality* protocol and workplace satisfaction in Portuguese dairy farms

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Objectives: The objective of this study was to evaluate the relationship of animal welfare of ten dairy farms in Portugal with workplace satisfaction. We hypothesized that there are positive correlations among the Welfare Quality® protocol (WQ) results, and workplace satisfaction.

Methods and materials: Ten farms were used in this study and were visited between January and September 2021. Farm size ranged from 35 to 789 milking cows at the time of the visit. All animals were kept on an intensive-based free-stall production system with several diverse bedding choices and were milked twice a day, with with the exception of one farm where cows were milked three times a day. All farms were assessed for animal welfare using the WQ® protocol. Workplace satisfaction was accessed using a questionnaire. For each farm, a questionnaire was delivered to the farm manager and to all of the working staff. The questionnaire is an adaptation of the one used by Phillip Durst et al. (2018) in *"Evaluation by employees of employee management on large US dairy farms"*. All data was organized in Microsoft® Excel for Mac version 16.56. The questionnaire was divided into 4 parts. Part 1 of the questionnaire consisted in a demographic and work conditions characterization with multiple selection, and short answer questions. Parts 2,3, and 4 were the parts considered in the Employee Satisfaction Index (ESI) calculation and referred to work environment, satisfaction, and relationship with manager. Part 2 consisted of a binary response ("Yes"- 5; "No"-1). Parts 3 and 4 answers were obtained using a 5-point Likert scale. In order to assess workplace satisfaction, ESI was calculated, using the guidelines proposed by Singh et al., (2014). All negative answers were aligned to provide a correct answer scale. Both managers and staff questionnaires were considered in the calculation of ESI. Afterwards, the applied formula was:

Employee Satisfaction Index (%) = (Total score received/ Maximum total score possible)×100

Results: From the farms considered in the study, 80% obtained the "Enhanced" level, while farms H and I were classified as "Acceptable" as the Final Score. No farms were classified as "Excellent" or "Not Classified". All ESI results are described in table 3, alongside the percentage of respondents for each farms. Among the correlations, the strong positive correlation with the "Comfort around resting" indicator (p= 0.069) and the "Good Housing" principle (p= 0.069), tended to be significant. Also, there was a strong negative significative correlation between ESI and the "Good human-animal relationship" criteria (p= 0.042). The remaining correlations between the WFQ and ESI showed no significance ($p ≥0.150$).

Conclusions: Our results reinforce the need to discuss further the impact of workplace satisfaction on animal welfare, specifically regarding the "Good human- animal relationship" criteria.

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