Background: Many dairy operations worldwide are increasingly relying on hired labor, especially foreign-born workers. However, many dairy managers have limited human resource knowledge and experience; this often leads to frustration with protocol drift and a sense that employees are not motivated to enhance the success of the farm beyond prescribed instructions. Yet, a large majority of dairy managers state that hiring and retaining employees is a top priority of their dairy enterprise, even though employee turnover varies widely between dairy operations. Taken together, these gaps in dairy farm labor can be described as a cultural lag. That is, there is a gap between the human resource needs within the industry's labor force and the capacity of producers and managers to address them. Herds that believe that 'mastitis was a problem in their herd' or 'had difficulty with compliance of milking protocols', are more likely to have higher BTSCC. Thus, employee management and training, as well as producer values and attitudes regarding mastitis, are also related to milk quality.

Results: When herd owners or managers were asked in a survey, "Who trains new employees how to milk cows?", 90% responded that they perform the training. However, when the employees were asked the same question, only 23% stated they learned how to milk from the managers or owners; 78% said they learned from other employees, or they just "learned on the job". Employee responses examined by language (Spanish-speaking and English-speaking) showed that only 14% of Latino workers said they learned the milking protocols from managers or owners, which was lower than English-speaking workers. Additionally, focus group discussions found that employees strongly expressed their appreciation for education, which helped them better understand ***why*** they do their tasks and the importance of those tasks. Separately, dairy producers also noted the positive attitude of employees brought about by veterinarian-initiated education and cited several examples of improved interest and team effort on the part of the employees in the work they performed.

Conclusions: We believe that engaged employees take the initiative and work to get the desired result for the dairy operation, beyond just "doing the job." We further believe that "on-farm education", facilitated by "science teachers" who provide hands-on training, such as veterinarians, can positively impact employee engagement and thereby improve productivity on dairy operations. Proactive, routine, training, followed by 1) accountability and performance metrics, and 2) a farm culture that promotes employee feedback—such as milking efficiency analysis of a milking protocols as described in an earlier paper (Erskine) at this congress—can result in better employee engagement, more consistent protocol compliance, less employee turnover, and improved farm productivity.

Lameness

K38

Dairy cattle lameness; where does recent research take us?

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Introduction: Lameness is undoubtedly one of the most critical challenges the dairy industry faces today. The condition is painful, and described as one of the clearest indicators of compromised welfare in dairy cattle (Bicalho and Oikonomou, 2013). This talk will be focused on how research currently conducted at the University of Liverpool and elsewhere is attempting to fill gaps in our understanding of lameness. We will discuss new research regarding the aetiopathogenesis of claw horn lesions (CHL), the role of the foot skin microbiome in the development of digital dermatitis lesions and developments in the field of automatic lameness detection.

Aetiopathogenesis of claw horn lesions: Despite the importance of CHL, their aetiopathogenesis is not yet fully understood. We have enrolled 2,352 Holstein dairy cows from four farms in the UK and recorded presence of foot lesions at four time points from before calving to late lactation. Cows were also genotyped. Measurements of foot angle, heel depth, backfat thickness, longissimus dorsi thickness, digital cushion thickness, and sole and foot skin temperature were taken from all studied animals to assess their role in CHL development. Additionally, measurements of the serum concentration of beta hydroxybutyrate, non-esterified fatty acids, insulin, relaxin, proinflammatory cytokines, and endotoxins have been obtained on a subset of animals as potential contributors to the aetiopathogenesis of the disease.

The role of the foot skin microbiome in the development of digital dermatitis.

Digital dermatitis is a painful, infectious, foot skin disease that compromises the welfare of hundreds of millions of production and wild ruminants. Disruption of the healthy skin microbiome has been associated with several diseases in humans. Associations between host genetics and skin integrity and/or skin microbiota profiles have also been described. We have recently showed intriguing interactions between host genetics and the foot skin microbiota profiles in cattle but the significance of host–microbiome-pathogen interactions in the development of DD lesions has not yet been studied in depth.

Automatic lameness detection.

Early lameness detection has been shown to be an important aspect of lameness management in dairy herds (Groenevelt et al., 2014) and yet for the most part relies on visual mobility/ locomotion scoring by farm staff or trained scorers. This process, albeit useful, can be time consuming and subjective even when agreement within the same experienced assessor is examined. CattleEye Ltd has recently developed and commercialised a system for automatic lameness detection. This system is the first to utilize inexpensive 2D surveillance cameras placed above the passageway exiting the milking parlour. Footage of cows exiting the milking parlour is sent directly to company servers where it is stored and processed.

The final result of the analysis is a number between 0 and 100, indicating the degree of lameness in relation to changes observed between reference points in each frame and changes observed between frames. We recently conducted a study to evaluate the performance of this video surveillance system for automatic detection of dairy cattle lameness. Our aim was to investigate the validity of the mobility scores provided by the system by comparing them against those recorded by two experienced assessors. Additionally, we examined the system's ability to detect cows with potentially painful foot lesions. Our study showed that the CattleEye system had a comparable performance to two experienced scorers when mobility score was used as a reference and outperformed the human scorer when lesion presence was used as the gold standard (Anagnostopoulos et al., 2021).

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K39

Sensible Treatment of Claw Disorders including Pain Management

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Objectives: To review common approaches to treatment of claw disorders with emphasis on what therapies are useful and which are potentially counterproductive? To suggest a sensible treatment strategy that incorporates a comprehensive plan for pain management.

Materials and Methods: Information for this presentation has been derived from personal research and a review of pertinent literature on the subject of the treatment of claw disorders.

Results of a 2-Part ISU Study: *A survey of veterinarians and hoof trimmers in North America* on treatment practices indicated that topical treatments for claw horn lesions were used by 59% of veterinarians and 53% of hoof trimmers. The medication used most frequently was the soluble powder form of tetracycline or oxytetracycline (48% by veterinarians and 81% by hoof trimmers) followed by copper sulfate for veterinarians and ichthammol ointment (a sulphurous, tarry compound with mild antiseptic properties used primarily as a drawing agent) for trimmers (Kleinhenz, 2014).

Results of the survey prompted a follow-up study to determine the effect of topical treatment with oxytetracycline soluble powder or powdered copper sulfate on the rate of wound healing in 18 cows with claw lesions. Cows were randomly divided into a treatment group: treated topically with oxytetracycline soluble powder (7) or copper sulfate powder (3) and a bandage; and a control group (8): no topical treatment and a bandage. Photos of lesions were taken at 24 hours post treatment when the bandages were removed and again at day 21 following the day of treatment. Photos were evaluated by 2 independent observers who scored the lesions for the visual presence of granulation tissue and evidence of re-epithelization. Based upon observer scores at day 21, lesions topically treated with oxytetracycline or copper sulfate were more likely to have abnormal or exuberant granulation tissue (observer agreement on 15/18 observations, $p > 0.0054$) and less likely to have evidence of re-epithelization (observer agreement on 11/18 observations, $p > 0.0553$). Although the number of observations is admittedly small, these data suggest that topical treatment with oxytetracycline or copper sulfate may delay wound healing (Shearer et al., 2015).

Tetracyclines are known for their ability to cause tissue irritation when used intramuscularly and copper sulfate is corrosive to the skin and eyes. Information from the equine literature indicates that treatments with low pH and corrosive properties cause cellular toxicity, which is likely to interfere with cell migration and proliferation in the early stages of wound healing.

Use of a Bandage: Despite evidence of a therapeutic benefit, the use of a bandage for the treatment of claw lesions was cited as a routine procedure for 53% of both veterinarians and hoof trimmers alike. A well-bandaged foot simply looks better and leaves one with the sense of a more professional job. However, these esthetics are short-lived as the housing systems for most dairy cows requires them to parade through a footbath or enter a manure slurry covered floor. What started out as a clean medicated bandage soon becomes one soaked in footbath solutions and organic matter. Possibly, it is for these reasons in part that healing was delayed by the use of a bandage in three well-controlled studies (White et al., 1981; Pyman, 1997; Kluwitter et al, 2019).

Sensible Treatment of Claw Lesions: There is little dispute that corrective trimming and the use of a foot block to elevate an injured claw make good sense. However, based upon available literature and the studies cited above, there is little justification for the *routine* topical treatment in combination with the use of a bandage. More important than selecting a topical treatment or a what kind of bandage to use is having a plan that assures prompt examination and treatment of lame cows. Finally, claw lesions are painful; provisions for managing pain whether associated with therapeutic trimming or during the post treatment period are important considerations. A multimodal treatment regimen would include the following:

1. use of intravenous regional or ring block anesthesia for corrective trimming
2. sedative-analgesics to reduce the pain and anxiety
3. careful corrective trimming avoiding injury to adjacent healthy corium tissues,
4. use of an orthopedic foot block
5. administration of analgesics in the post treatment period

6. comfortable housing and attentive management of lame cows' post-treatment.

K40

Factors affecting claw lesion healing in cattle

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Objective: Wound healing is a complex process generally described in terms of 4 overlapping phases including: *hemostasis, inflammation, proliferation* and *maturation*. The objective of this session is to describe wound healing in the context of claw lesions with emphasis on the factors that may interfere with these events.

Materials and Methods: Information for this presentation has been derived from research observations and a review of pertinent literature on the subject of wound healing.

Wound Healing as it applies to Claw Lesions: Restoration of a new layer of epithelium (new hoof horn) on the surface of exposed corium is the primary objective in claw lesion healing. Wounds that result in significant tissue loss or those that are heavily contaminated are generally left open to heal by 2nd intention. Wound edges cannot be opposed as with sutures and lesions are generally contaminated requiring closure of the defect by granulation, and eventually re-epithelization of the granulating tissue surface. Bridging the gap between wound margins, depending upon size and depth of the lesion may be prolonged.

The 4 Phases of Wound Healing.

Hemostasis: Hemorrhage plays a key role in wound repair as the source of blood platelets essential for blood clot formation. Within minutes, platelets enter the site of injury and begin to clump forming a clot. Coincident with the clotting process is the release of numerous cytokines and vasoactive mediators that cause vasoconstriction to reduce blood loss and activate inflammatory cells in preparation for the second phase of the healing process (Stadelmann et al, 1998; Auer and Stick, 2012).

Inflammation: The inflammatory phase is characterized by the influx of white blood cells that phagocytize bacteria and cellular debris within the site of injury. This phase is characterized by pain, swelling and loss of function at the wound site. Quite often, chronic lesions or wounds are those stuck (or stalled) in the inflammatory phase of healing.

Proliferation: The proliferative phase is characterized by angiogenesis, fibroplasia and granulation tissue formation and epithelialization. Any interference in these events has the potential to result in prolonged wound healing and a chronic lesion. The timing of topical treatments frequently coincides with key events that occur during this period.

Whereas hemostasis occurs within minutes and inflammation within minutes to hours after injury; the proliferative phase marked by the entry of fibroblasts and the formation of granulation tissue begins in 2-3 days of injury. Neovascularization supports the development of granulation tissue that fills the wound defect. Although less resistant to external factors than intact skin, granulation tissue provides an early, though imperfect, barrier to injurious agents from the environment (Stadelmann et al, 1998; Auer and Stick, 2012).

Re-epithelialization of the lesion is the ultimate objective in wound healing. The speed of re-epithelialization depends upon the severity and type of injury suffered. For example, re-epithelialization is rapid when the injury is superficial (i.e. such as an abrasion) and the basement membrane and basal cell layer are intact or minimally damaged. On the other hand, when a full thickness defect of the epithelium occurs the recovery process is prolonged. In this circumstance, residual keratinocytes at the wound site are not immediately available for recruitment to start the healing process. Instead, re-epithelialization must occur from the wound edges requiring centripetal movement of keratinocytes from the wound margins (O'Toole EA, 2001).

Persistent or Exuberant Granulation Tissue.

The clinical indication of an interference with wound healing is the presence of exuberant granulation tissue (Auer and Stick, 2012). This is corroborated by the observations that ulcers with excessive granulation tissue healed more slowly compared with lesions free of granulation tissue (van Amstel et al, 2003). Re-epithelialization of mild to moderate lesions requires somewhere around 21-30 days with more severe lesions requiring as much as 40 days and potentially as long as 60 days.

Causes of Non-Healing Claw Lesions.

One of the most frequent causes delayed claw lesion healing is infection of the exposed corium by organisms associated with digital dermatitis. The longer the corium remains exposed, the greater the likelihood of secondary infection. Complicating factors include bandaging and topical treatment of claw lesions among others. An understanding of the factors that affect claw lesion healing is important to assure a successful outcome from treatment.

K41

Dairy cattle lameness genetics; can we breed lameness out of our herds?

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Genetic selection alone will not fully address the issue of dairy cattle lameness as environmental effects (i.e. housing, diet, foot trimming practices etc) have a strong influence on herd lameness prevalence. However, genetic selection can definitely complement efforts to decrease lameness prevalence through improved management and may actually have a more important role to play than previously thought.

The University of Liverpool (in collaboration with SRUC and the Royal Veterinary College) is currently conducting a large-scale study on the genetics of cattle lameness. 2,352 Holstein cows were enrolled on four dairy farms and subse-

quently assessed at four stages of a lactation cycle. At each stage, feet were inspected by a veterinary surgeon and all foot lesions were recorded and scored according to severity. Cows were genotyped and genetic indexes were assigned to each cow following national genetic evaluations. Combining data from all stages indicated that the heritability of the susceptibility to sole haemorrhages, sole ulcers, and white line lesions was 0.29, 0.35 and 0.10, respectively. Initial analyses on digital dermatitis suggest heritability estimates greater than 0.30. We also studied cows' ability to recover from sole lesions and showed a heritability of 0.27; this was only weakly correlated to sole lesion susceptibility. This suggests there is potential to selectively breed cows which can recover from sole lesions more effectively, but selecting for reduced susceptibility alone is unlikely to achieve this. Efforts to reduce the prevalence of chronically lame cows could be more successful if genetic selection for sole lesion recovery is considered alongside selection for reduced susceptibility. We also found that heritability estimates of digital cushion thickness ranged from 0.23 – 0.44 and 0.14 – 0.29 depending on the location of fat pad measurement. Our results clearly highlight the potential for genetic selection to improve resistance to lameness and the importance of accurate phenotyping. Genome-wide association analyses of claw horn lesions and digital cushion thickness traits revealed a polygenic background; candidate genes were identified with roles in immunity and inflammation, and in carbohydrate and lipid metabolism.

The same dataset was also used to evaluate the current performance of Lameness Advantage (UK lameness genetic evaluation) and the results were very promising (Barden et al., 2022). The odds ratios (95% confidence intervals) for one-point increase in the Lameness Advantage index were 0.79 (0.72 - 0.86), 0.68 (0.59 – 0.78), 0.94 (0.84 – 1.04), and 0.82 (0.74 – 91) for sole haemorrhage, sole ulcer, white line disease, and lameness, respectively. The same trends were present when the sire's Lameness Advantage index was evaluated in place of the animal's own, although the strength of this association was generally weaker. Effectively, for every two-point decrease in Lameness Advantage (worse genetics for lameness) the sole ulcer risk doubled. Similar associations were observed between the digital dermatitis genetic index and actual incidence of digital dermatitis. Effectiveness of the Lameness Advantage and digital dermatitis indexes will increase if farm lesion records improve and foot-trimming records include all lesions and are recorded on-farm software.

The additive genetic variance of foot lesions could be utilised to select for increased resistance to these lesions; novel traits such as DCT and sole lesion recovery may also be useful traits for this purpose.

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Genetics and Breeding

K42

What every farm advisor should know about dairy cattle breeding

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Genetic selection is a very powerful tool for achieving lasting gains in dairy cattle performance. Contrary to improvements in nutrition, management or cow comfort, changes achieved through selection are incremental, cumulative, and permanent, which makes genetic improvement a very cost-effective strategy.

The basics of dairy sire selection: Dairy bulls are genetically evaluated for several traits, including different production, health, fertility, and type traits, and this genetic information is regularly compiled and published by each specific breed organization as sire summaries. There are at least ***three key concepts*** that appear in the sire summaries that should be carefully considered when making sire selection decisions. These relevant concepts are ***predicted transmitting ability*** (PTA; a measure of the genetic merit of the bull for a given trait), ***reliability*** (REL or %R; a measure of the degree of confidence in the PTA of the bull), and ***percentile rank*** (a measure of the rank of the bull within the evaluated population for the trait of interest).

Dairy sire selection for multiple traits: There are many traits, including production traits (such as milk yield and milk composition) and functional traits (such as fertility, health, longevity, and calving ability), that directly impact the profitability of any dairy production enterprise. The best method for selecting animals considering multiple traits is the use of an ***economic selection index***. This method combines multiple traits of interest into a single value, greatly facilitating the identification of the best animals. Individual traits are weighted based on relevant genetic information and their economic importance; these economic weights are based on current prices for both inputs (e.g., feed and veterinary costs) and outputs (e.g., milk prices) of a dairy production enterprise. These values are updated regularly to reflect current trends in the price of feed and milk.

K43

Economic trade-offs between productive life and genetic progress

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The rate of genetic improvement in dairy cattle has doubled in the last decade, in part due to the use of genomic testing which has greatly shortened generation intervals. As-