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LAMENESS IN DAIRY CATTLE:

Exploring different methods of knowledge transfer and how they influence behaviour change in dairy producers and lameness prevalence in their herds.

Final Report: March 2023

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Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
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Summary

This project sought to investigate different methods of knowledge exchange in relation to lameness in dairy cattle and how this influenced farmers' perception of lameness, their knowledge and behaviour change. It involved 24 dairy farmers in southeast Wales who self-selected one of four groups they joined based on their preferred method of knowledge exchange. One group received no input (control group) and the remaining groups either received one-to-one advice through the Healthy Feet Lite Programme (HFLite), participated in a Farmer Led Action Group (FLAG) or received both the HFLite and attended a FLAG.

Farmers rated lameness as a significant concern to the dairy industry in Wales, citing welfare, public perception and impact on production and profitability as reasons for this. Levels of concern regarding lameness on their own farm varied, as did the ability to accurately identifying the level of lameness in their herd. At the start of the project all farmers underestimated lameness levels in their herd. Recognition of lameness improved over the course of the project, and this then also impacted on what they thought was an achievable target for lameness on farms. The majority of farmers gave a higher target at the end of the project based on their improved knowledge regarding true lameness prevalence as well as the challenges faced when tackling lameness.

Overall farmers rated the FLAGs as more valuable than the HFLite and were more likely to continue with these after conclusion of the project. Receiving advice that was practical and directly related to their own farm situation was highlighted as very important. Using a highly skilled foot trimmer was identified as the biggest positive influence on farmers ability to manage lameness. Restrictions due to Bovine TB was identified as the greatest negative influence.

On average farms in the Intervention Groups implemented more changes in relation to lameness, saw a larger decrease in lameness and a larger reduction in costs associated with lameness in comparison to farms in the Control Group. Alongside these benefits, farmers that received input were more likely to feel more positively towards lameness in their herds at the end of the project. At the start farmers described feeling 'anxious', 'concerned' or 'overwhelmed' by lameness. Following the project, they described feeling 'empowered', 'comfortable' and 'positive'.

Background

Lameness presents a significant welfare concern and both a financial and reputational risk to the dairy industry. The most recent prevalence studies indicate that 1 in 3 cows are lame at any one time (Griffiths et al. 2018; Randall et al. 2019). Despite a significant drive towards the reduction of lameness over the last twenty years, there is no substantial evidence to indicate that the national picture is improving.

It is commonly identified that farmers underestimate the levels of lameness in their herds (Whay et al. 2003; Leach et al. 2010) with early research surrounding lameness identifying that the majority of producers could only identify lame cows that showed an obvious limp (Mill and Ward 1994). Horseman et al. (2014) found that the term 'lame' was mostly reserved for severely affected cows. Therefore, in order to address lameness, there often needs to be change in the way lameness is perceived or defined by the farmer through improved awareness of the true prevalence of lameness in the herd.

Behaviour change is a complex process and farmers follow patterns similar to the general population. Various approaches to motivating producers have been shown to work, including social marketing and motivational interviewing, though these have predominantly targeted at individual farmers/businesses. In some instances, the motivation or desire to improve is present but when it comes to implementing improvements, often the barrier to improvement is not a lack of knowing *what* to do, but *how* to practically implement ideas, particularly when time and resources are limited.

The methods of knowledge transfer selected for this project focus on the practical implementation of ideas rather than on simply raising awareness of lameness issues. More specifically it will investigate whether the Scandinavian Stable School methodology developed by Vaarst et al., (2007) can successfully be applied to lameness control and whether one off interventions, such as the HFLite translate into change on farm or whether combining this with ongoing peer support yields better results.

Aims of the Project

The aim of the project was to explore how different methods of knowledge transfer influenced farmers' perception of lameness, their knowledge and behaviour change.

The sub-objectives were to determine how these methods of knowledge exchange related to changes in lameness prevalence and whether Farmer Led Action Groups could provide another means of increasing farmer engagement in lameness control.

Participants

The project involved 24 dairy farmers located across Southeast Wales (Figure 1) totalling 5,422 adult dairy cows (average herd size 226; range 80-800). The farms comprised of a range of different breeds; Holstein (16), Holstein x Friesian (5), British Friesian (1), Holstein and Shorthorn (1) and Jersey (1). Of the 24 farms, 16 were calving all year round, 4 in an autumn block and 2 in a spring block. Five farms milked through robotic milking systems and the remainder through conventional parlours with 4 milking three times, 14 twice and 1 farm once a day. The average milk per cow per year was 9,104 litres (range: 3,500-11,500 litres). Total milk sold per year across all farms was 54.8 million litres.

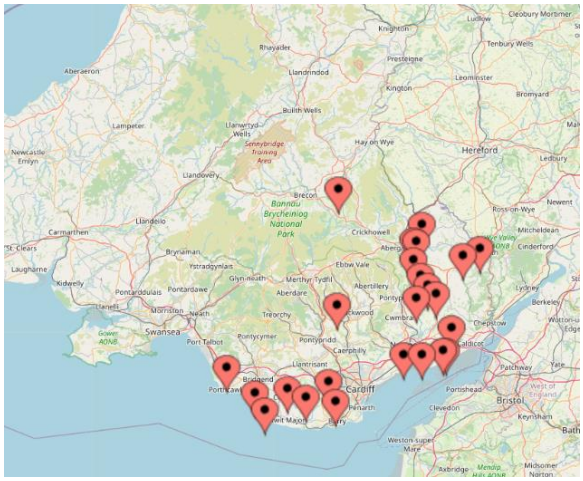

Figure 1: Location of the 24 dairy farms participating in the project

Methodology

In total 24 farmers were recruited on to the project through their vet or Farming Connect Development Officer. Farmers were not randomly allocated to a group and instead were allowed to select their Group based on their preferred method of knowledge exchange. The Groups are as follows:

GROUP 1: CONTROL. No intervention.

GROUP 2: ONE-TO-ONE ADVICE FROM VET. Farmers received direct, targeted advice through implementation of the AHDB Healthy Feet Lite Programme (HFLite) with their own trained vet (Mobility Mentor).

GROUP 3: PEER LEARNING. Farmers receive no specialist advice but share knowledge and ideas through a facilitated Farmer Led Action Group (FLAG) with each farm hosting two meetings over the course of the project.

GROUP 4: COMBINATION OF ONE-TO-ONE ADVICE AND PEER LEARNING. Farmers received both the HFLite with their own vet and peer support through a Farmer Led Action Group.

Healthy Feet Lite (HFLite)

Farmers in Groups 2 and 4 implemented the AHDB Healthy Feet Lite Programme (HFLite), which was delivered by a trained Mobility Mentor (a vet who has undergone further training in lameness). The HFLite is a first step approach to lameness control and is centred on identifying and then tackling the key risk factors for lameness on an individual farm.

The HFLite involved the following steps:

Step One: Independent mobility score to determine herd prevalence.

Step Two: Record analysis to determine most common causes of lameness and help focus the risk assessment on the key risk factors for the individual farm.

Step Three: On farm visit for risk assessment and action plan formulation. The visit is focused on the HFLite checklist that is relevant to the most prevalent lesion(s):

Sole ulcers:	Cow Comfort/BCS
White line disease:	Cow flow/BCS/horn quality
Digital dermatitis:	Infection pressure

Assessment of early detection and prompt, effective treatment is included in all scenarios.
At the end of the visit an action list of priorities is drawn up through a facilitated process with the farmer.

Step Four: Review of actions completed at 12 and 24 months and generation of new action lists.

Farmer Led Action Groups (FLAGs)

Farmers in Groups 3 and 4 attended Farmer Led Action Groups (FLAGs). These were based on the Danish Stable School approach which were initially implemented to assist in improving awareness of antimicrobial resistance and the need to reduce antibiotic usage through common learning (Vaarst et al., 2007). The aim of this approach is to facilitate knowledge exchange between farmers working with similar challenges and enable them to give practical advice to each other. They differ from the traditional discussion group format which typically focus on many topics and involve an advisor or vet as the 'expert'. The Stable School approach puts farmers in charge of the process and so they set the agenda, choose the problems and

identify the solutions. The facilitator avoids taking on the role of advisor and focuses instead on ensuring the meetings are well-organised, disciplined, well-documented and running to time. As soon as the facilitator assumes a technical advisory role the dynamic of the meeting reverts to a conventional client-advisor relationship with the disruption of the peer-to-peer learning.

Within Group 3 and 4, each member hosted one meeting per year long cycle. Meetings were held every 1-3 months, on a day most convenient for the group. The meetings were held between 11am and 1pm to ensure that they were succinct and focused.

Prior to the meeting the facilitator (Sara Pedersen - SP) contacted the host farm to identify 1-2 problems that they wanted to have input on helping to address as well as a success story that could be shared with the group. An agenda was circulated prior to the meeting via a WhatsApp group which was set up for each group. As Group 4 were also undertaking the HFLite, copies of the farm's Action Plan were also provided for discussion.

Each meeting started with a brief introduction by the host and then a farm walk. Details relevant to the success story were covered and the problem(s) introduced at the relevant point in the farm walk. The facilitator prompted questions and maintained meeting momentum but did not provide any technical input during discussions.

The second part of the meeting was held either outside or in a farm meeting room, dependent on the Covid restrictions at that timepoint. A flipchart was used to gather input from the group on how to tackle specific problems raised by the host alongside any other aspects where they felt changes could be made to benefit to hoof health. Each farmer was able to provide their input in turn so that everyone could provide input. Once all ideas had been captured, the host was then able to ask for further clarification on any of the points before either agreeing or disagreeing to take each point forward as an action. The notes from the flipchart were summarised and circulated via the WhatsApp group.

During the second round of meetings the previous agreed actions were reviewed at the start of the meeting to identify what had or hadn't been implemented. Feedback was also sought on any actions that had been implemented and the effect that this had had on hoof health.

At the end of the first round of meetings the farmers in Group 3 requested that an element of benchmarking was introduced so that they could monitor progress within the group and also compare themselves to farms within Group 4 who had also formed a FLAG. Lameness prevalence was benchmarked along with the reported lesion incidence based on foot trimming records.

Figure 2 shows an example of one of the benchmarking graphs used as a point for discussion during the meetings. Foot trimming records were used to record the number of cows in the herd identified as having a major foot lesion (digital dermatitis, sole ulcer, white line disease and toe lesion) over a twelve-month period. This additional information was deemed highly valuable by the FLAG members and a useful additional element to the discussion base. As the information was updated for each meeting it was also felt that it was perhaps more reflective of a herd's progress than the single annual assessment of lameness prevalence.

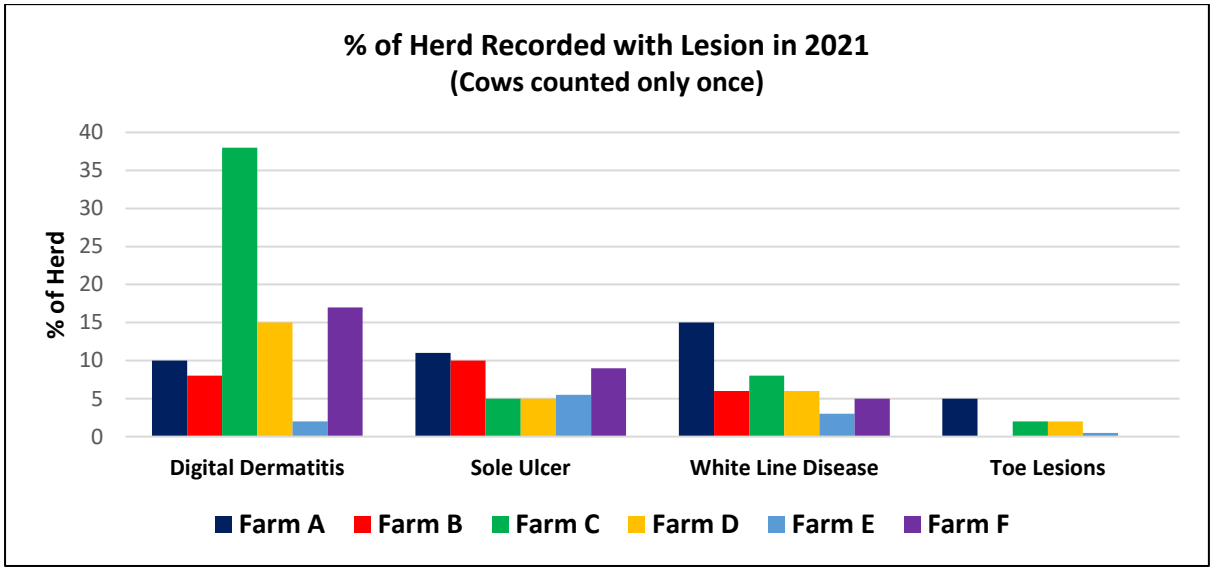

Figure 2: Example graph showing benchmarking of lesions recorded at foot trimming between different farms within one of the Farmer Led Action Groups.

The use of the foot trimming data in this way did also highlight several limitations. Due to different foot trimmers being used across members of the different groups there was a lack of consistency in recording, and this therefore had an influence on some of the results. For example, one foot trimmer only recorded large, active cases of digital dermatitis whereas

another recorded all lesions regardless of size. It was also acknowledged that the results would be heavily biased by the number of cows presented for the foot trimmer and how these cows were selected.

Further analysis was undertaken for each host farm to help identify patterns and risk periods for each major lesion and this helped to drive discussions during the meeting. Analysis was undertaken at cow level such that if a cow presented with a sole ulcer in her right hind but was subsequently recorded as having a new ulcer her left hind, the second case was counted as a repeat case. The rationale for this approach was that breeding and culling decisions are made at the cow level. Figure 3 shows an example from one herd to show the pattern of digital dermatitis cases recorded at foot trimming.

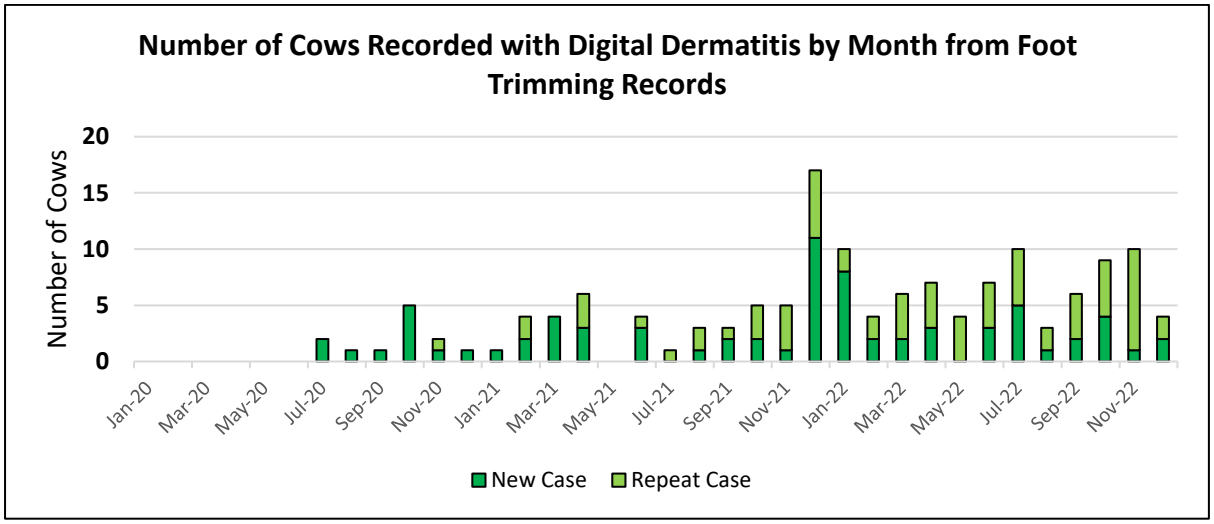

Figure 3: Example graph showing the number of digital dermatitis cases recorded each month during the project for one of the farms in a Farmer Led Action Group.

Based on Figure 3, the group discussed how the digital dermatitis was controlled early in 2020 through implementation of the 'blitz' approach. The rise in cases in December 2021 was also a focus for discussion and was identified as the result of footbathing frequency reducing in the period before Christmas. This resulted in not only a successfully story of control being shared within the group but also reinforced the importance of maintaining footbathing protocols.

Mobility Scoring to Monitor Prevalence

All herds were mobility scored at the start, midway and end points of the project i.e., approximately 0, 12 and 24 months. They were conducted as closely together as possible and at the same timepoint each year to reduce the effect of seasonality.

All mobility scores for the purpose of project were undertaken by the same Register of Mobility Scorer (RoMS) accredited scorer to ensure consistency (SP). The entire adult herd on each farm was scored following milking or during a set time for robotic herds. An adapted six-point scale based on the AHDB 0-3 Mobility Scoring system was used which further categorised Score 2 and 3 cattle into different categories of severity (Thomas et al., 2015; Table 1). The purpose of this was to monitor changes not only in overall lameness prevalence but also the severity of the lameness.

Score	Description
Score 0	**Good mobility:** Walks with even weight-bearing and rhythm on all four feet, with a flat back. Long, fluid strides possible.
Score 1	**Imperfect mobility:** Steps uneven (rhythm or weight-bearing) or strides shortened. Affected limb or limbs not immediately identifiable.
Score 2a	**Mild lameness:** Mild asymmetry in hindlimb movement. Decreased stride length on affected limb and slightly decreased stance duration with a corresponding increase in limb speed on the non-affected limb. Walking speed remains normal. Back may or may not be arched.
Score 2b	**Moderate lameness:** Moderate asymmetry in hindlimb movement. Decreased stride length on affected limb and a distinct decrease in stance duration. Limb speed on the non-affected limb is correspondingly faster and the overall walking speed is reduced. Back usually raised.
Score 3a	**Severe lameness:** Unable to keep up with the herd, lame leg easy to identify and back arched when standing and walking.
Score 3b	**Very severe lameness:** As score 3a but not weight bearing on limb. Reluctant to walk without encouragement.

Table 1: Definition of the adapted AHDB Mobility Scoring system used for mobility scoring all herds throughout the project.

Following each mobility scoring session farmers in intervention Groups 2, 3 and 4 were notified of their scores and, where applicable, a copy provided to their vet to assist with the HFLite visit. Farms in Group 1 (Control) were not given a copy of their mobility scores so not

to influence their behaviour, except where Score 3 (severely lame cows) were present in which case a list of these were provided to the farmer.

Pre- and post-study survey/questionnaire

At the start of the project a survey was conducted with all farmers in the Intervention groups (2, 3 and 4). The questionnaires were carried out either face to face or virtually and covered the following areas:

- Lameness in the Welsh dairy industry
- Details of the herd
- Approach to cattle mobility including levels of knowledge
- Lameness in their herd
- Lesion identification and treatment protocols

The aim of the survey was to identify current engagement in lameness management, knowledge levels and their perception of lameness both in their own herds and also within the context of the Welsh dairy industry.

At the end of the project another face-to-face survey was conducted on all 24 farms aimed at determining changes in lameness perception, knowledge level and changes implemented over the course of the project. For those in intervention groups, feedback was sought on how much they valued the advice they received, what could have made it more valuable and how their feelings surrounding lameness changed over the course of the project. During the post-project questionnaire, the mobility scores across all 24 farms in the project were shared so that individual farms could see how they compared with other farms in the project. The impact of this on how the farmer perceived their progress during the project was also explored.

Results and Discussion

Mobility score data was collected for all 24 farms at the start, middle and end of the project. The initial aim was to score all farms within a six-week period, however, this was constrained due to Covid-19 lockdown measures, therefore the first scoring took place between November 2020 and March 2021. To minimise the impact of seasonal changes in lameness risk, subsequent scores were undertaken as close as possible to 12 and 24 months after their initial score.

For the purpose of the analysis, Control Group refers to Group 1 and Intervention Groups refers to Groups 2, 3 and 4.

One farm left Group 3 due to time constraints midway through the project but completed the end of project survey, thus their results are included. One farm left Group 4 due to a change of herdsman and so an end of project survey could not be completed.

PERCEPTION OF LAMENESS IN THE WELSH DAIRY INDUSTRY

On average, farmers in the Intervention Groups rated lameness as very important to the Welsh dairy industry with an average score of 4.7/5 based on a scale of 1 (not important) to 5 (very important). All farmers rated it either 4 or 5/5 at the start of the project.

At the end of the project this remained unchanged overall. However, two famers rated it more important than they had done at the start of the project due to a change in their awareness and a perceived increased public perception risk. One farmer rated it at a lower importance (4 compared to 5) due to the influence of changes in lameness on their own farm.

The Control Group were asked the same question but only at the end of the project. Their responses ranged from 3-5 with an average of 4.25

The main reasons provided for it being rated as so important included welfare, impact on productivity/profitability and public perception (Figure 4). This remained unchanged at the start in comparison to the end of the project.

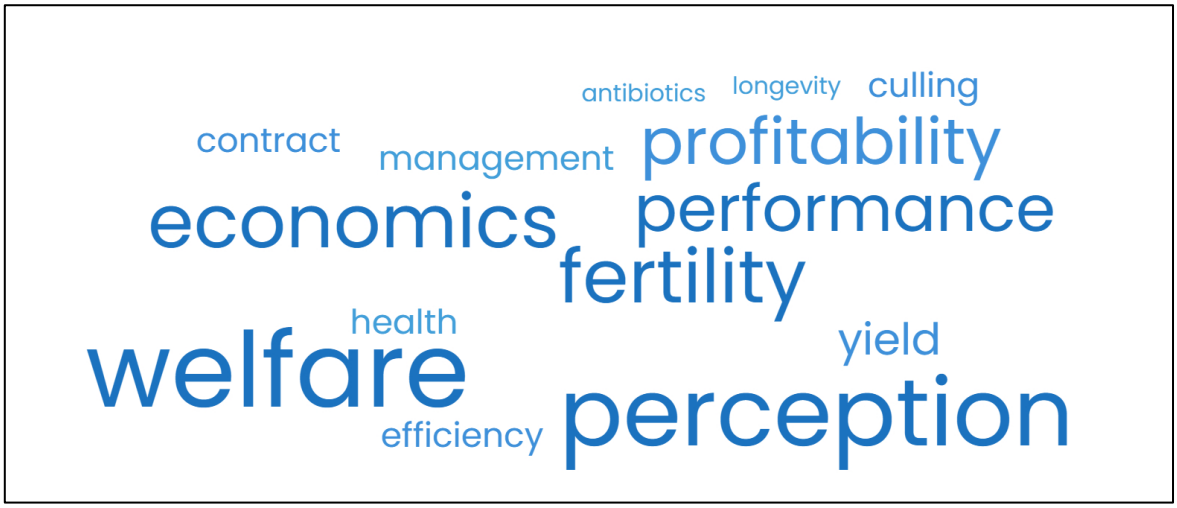

Figure 4: A word cloud of reasons provided by farmers as to why they felt lameness in the Welsh dairy industry was important at the start of the project. Only responses from farmers in Intervention Groups 2, 3 and 4 are shown.

At the start of the project farmers estimated the prevalence of lameness in Welsh dairy herds to be an average of 29.5% with a wide range of 10-70%. When asked to provide a target % this ranged from 0% to <50% with an average of 11.3%. At the end of the project this range narrowed to 4-25% with an average of 13.1%. The majority of farmers increased their target % over the course of the project and the reasons given for this were a greater awareness of the true prevalence of lameness on farm, the challenges when trying to address lameness and the period of time taken before reductions are seen as a result of changes. Many farmers acknowledged that whilst a target of 0% would be the ideal, this was not achievable, and an achievable target was more motivating and less demoralising.

The targets suggested by the Control Group ranged from <5% to 30%, with an average of 10.85%. When the opinions of all 23 farms were combined at the end of the project the average suggested target was 12.5%.

When asked about what the Welsh dairy industry did well or could do better in terms of tackling lameness there were a wide range of responses from those in the Intervention Groups. Existing funding streams (such as Farming Connect and HerdAdvance) and accessible training were the most frequently mentioned aspects. When asked what the industry could do better, the most common answer was to improve communication. This related to both being more open and honest about the true prevalence of lameness on farms and better promotion of the actions or changes that have had the biggest impact.

With regard to improving lameness within the Welsh dairy industry, Figure 5 shows the responses to the question '*What do you think the biggest barrier is when it comes to making improvements?*'. Out of the 18 responses, 11 cited financial resource as the main barrier to implementing desired changes which would improve lameness i.e., they wished to invest in improvements but having the funds to do so at the appropriate time was a challenge.

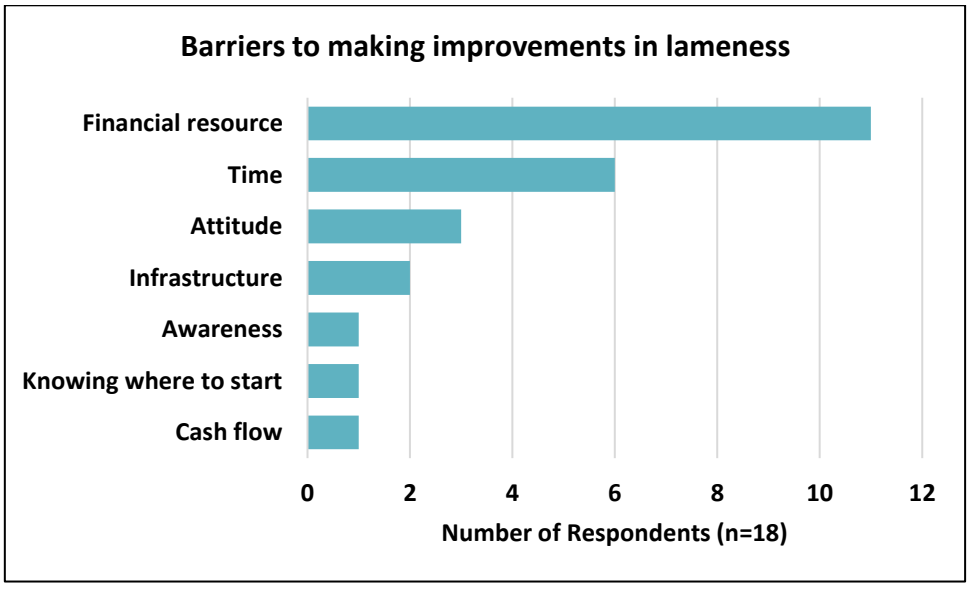

Figure 5: A bar chart showing the reasons provided when 18 farmers in the Intervention Groups were asked to state what they felt the biggest barrier with regard to improving lameness.

GROUP SELECTION: PREFERRED METHOD OF KNOWLEDGE EXCHANGE

During the end of project interview farmers were asked why they selected their group and whether they would have selected the same group again having completed the project. In summary, reasons for selecting the individual groups were as follows:

Group One (Control): All farms in this group selected this group as they either didn't perceive lameness to be an issue on their farm or they didn't have the time to commit to an intervention group.

Group Two (HFLite): The main motivators for selecting the one-to-one advice with the vet were the ability to focus solely on their farm and have dedicated bespoke advice in relation to their problems, as well as a lack of time to participate in group activities.

Group Three (FLAG): Reasons for choosing this group mostly centred around wanting to share knowledge and ideas with peers and work collaboratively with other farmers to tackle lameness.

Group Four (HFLite and FLAG): Farmers chose this group as they felt it would offer them maximum benefit for their involvement in the project, they would be able to benefit from two sources of knowledge and that it represented a greater opportunity to commit fully to tackling lameness.

IMPACT ON LAMENESS PREVALENCE

Due to sensitivities surrounding lameness prevalence in relation to contractual obligations, changes in lameness prevalence rather than actual mobility scores are reported. Cows were counted as lame if they were assigned a mobility score of 2a (mild), 2b (moderate), 3a (severe) or 3b (very severe).

Due to the nature of the project and the self-selection of groups a degree of bias was anticipated, and this was seen in the lameness across the different groups. As expected, the

average prevalence was lower in the Control Group in comparison to the Intervention Groups. However, not all farms in the Control Group had lower than average scores for the 24 farms enrolled. Figure 6 shows the positioning of the farms in the different groups from highest to lowest prevalence at the start of the project. Two Control farms were in the top half of the ranking.

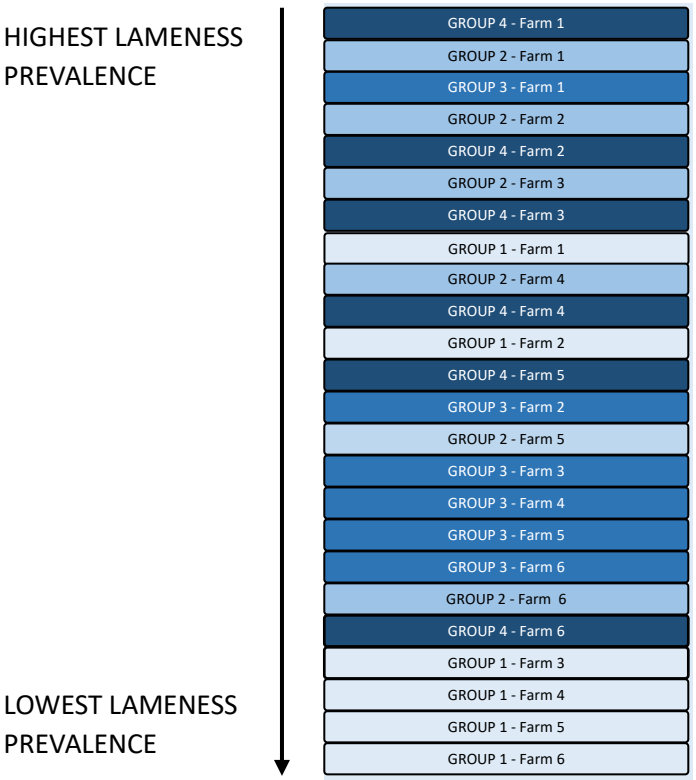

Figure 6: Ranking of farms based on lameness prevalence at the start of the study to indicate the position of farms in the different groups: Group 1 – Control; Group 2 – HFLite; Group 3 – FLAG; Group 4 – HFLite and FLAG.

At the start of the project all farms in the Intervention Groups were asked to estimate the prevalence of lameness in their herds. Every single farmer underestimated the true levels of lameness in their herd. The degree of underestimation ranged from 5-91%. The estimated levels of lameness were more aligned with the proportion of Score 3s (a and b) in the herd, as reported in previous studies (Whay et al., 2003; Leach et al., 2010). Those farmers who provided estimates closer to the actual prevalence of lameness had a tendency to have

previously been involved in lameness control programmes or knowledge exchange specifically around lameness e.g., Farming Connect Lameness Clinics or skills training.

Although by the end of the project there was still a tendency to underestimate the lameness prevalence in the herd there was less disparity between the perceived and actual mobility scores. In some instances, the mobility scores were not viewed as a true reflection of the situation on the farm and considered to represent a *'bad day'* or '*poor timing'* of the scoring.

Overall Changes in Mobility Scores

When comparing the lameness prevalence at the start in comparison to the end of the project, 18 farms saw a reduction and 6 farms an increase in the proportion of the herd scored as lame. Half of the farms that saw an increase in lameness were in the Control Group. Across all farms there was a decrease in lameness prevalence by an average of 7.1% which ranged from a 4.9% increase (Group 1 Control farm) to a 27.9% decrease (Group 4 farm). Figure 7 shows the change in lameness for each individual farm in the project and which group they were in. Where a negative value is shown this represents an increase in lameness.

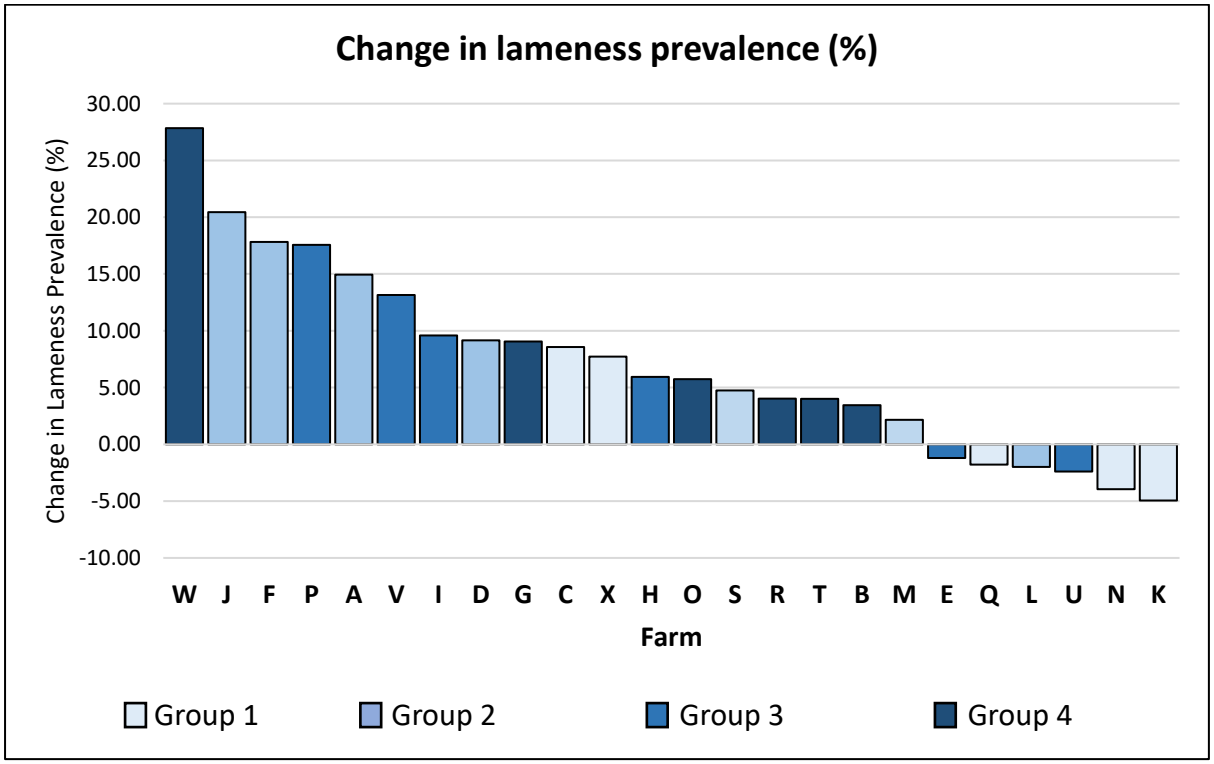

Figure 7: A bar chart showing the change in lameness prevalence between the start and end of the project for each of the 24 farms.

The average reduction in lameness prevalence by group was 1.3%, 10.9%, 7.1% and 9.0% for Groups 1, 2, 3 and 4 respectfully. When all Intervention Groups are considered together the average reduction was 9.0% in comparison to 1.3% for the Control Group.

A paired t-test was undertaken to assess whether there was a statistical difference between the start and end scores in the Control versus Intervention Groups. Table 2 shows the outcome of the test. There was a highly significant reduction in lameness prevalence in the Intervention Groups ($p<0.01$) whereas this effect was not seen in the Control Group. The lower initial lameness prevalence of four farms in the Control Group would have limited the possibility of substantial reductions in lameness prevalence and thus biased the outcomes to some degree. However, the fact that increases in lameness were seen in 3/6 of the farms in Group 1 would provide added weight to the positive impact of the Intervention Groups since increases were seen in a smaller proportion of these farms (3/18).

	Control Group		**Intervention Groups**	
	Start	*End*	*Start*	*End*
n	6		18	
Mean Difference	1.30		9.01	
SD	9.50	5.98	9.24	7.73
SEM	3.88	2.44	2.17	1.82
P value	**0.61**		**0.0002**	

Table 2: Outcome of a paired t test to assess the statistical significance of differences in lameness prevalence at the start and end of the project in the Control versus the Intervention Groups.

ACTIONS IMPLEMENTED

Actions implemented during the project were recorded at each HFLite review, FLAG meetings and at the end of the project for the Intervention Groups. The Control Group were asked to recall any changes made over the course of the project in relation to lameness.

There were a wide variety of actions implemented which varied from those requiring time e.g., increased mobility scoring, to those requiring considerable capital cost e.g., new housing. In Groups 3 and 4 which incorporated FLAGs, additional changes were made aside from those on the suggested action lists. This was a result of picking up new ideas during the farm meetings e.g., one farm changed sand supplier having seen a higher quality of sand during a meeting on another farm. It was also apparent that the FLAGs assisted in the practical application of some of the suggested actions created through the HFLite. For example, during one farm visit it was indicated on the HFLite action plan that the cow track should be extended to reduce poaching. However, there were both cost and logistical challenges involved with this action. During the FLAG meeting another farmer recommended a simple diversion which would cost no additional investment to create but would instantly address the issue.

The total number of changes made across all 23 farms was 160 (range 1-16). The average number of changes made per farm in each group is shown in Figure 8 (note only 5 farms were included in Group 4 at the end of the project).

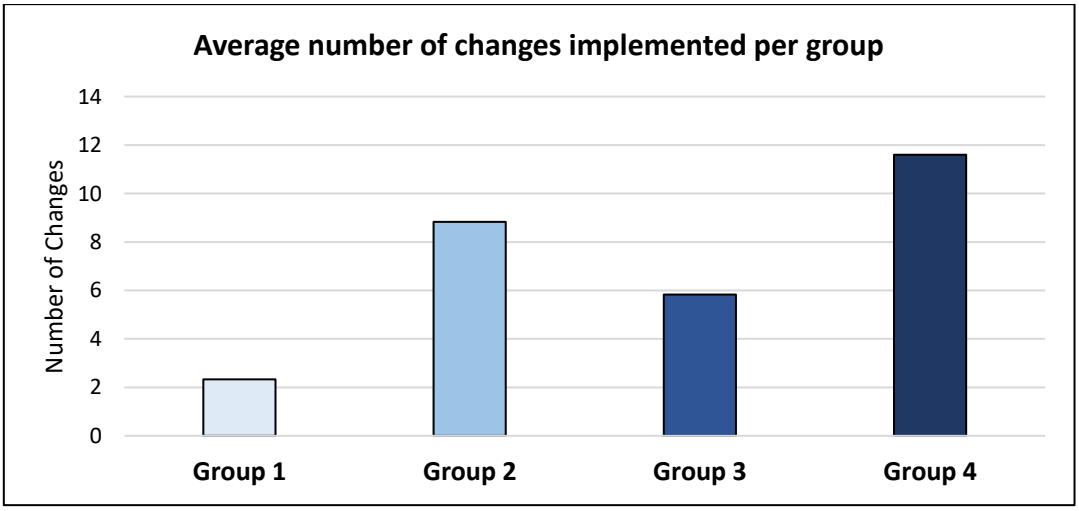

Figure 8: A bar chart showing the average number of changes implemented per group.

It is important to note that farms in Group 2 and Group 4 had the HFLite visits at the start of the project with a review and renewed action plan at the midway point. This provided them with a longer period of time to implement changes in comparison to farmers in Group 3 who may have hosted the FLAG meeting at the end of the round i.e., almost 12 months into the project. Group 3 also included a farmer who implemented a very low number of changes during the project since they had already engaged in a lameness control plan previously. However, including them in the group allowed others to see what difference these changes had made on lameness and therefore provide more confidence to the rest of the group that the changes would be beneficial on their farms.

POSITIVE AND NEGATIVE IMPACTS ON ABILITY TO CONTROL LAMENESS

Farmers in the Intervention Groups were asked which single factor they felt had had the greatest *positive* impact on their ability to control lameness. Half of the farmers responded that this was changing to a highly skilled foot trimmer (i.e., qualified and regularly audited). The reasons for this were that they saw fewer problems after routine preventive trimming and an improvement in recovery of lame cows. As a result, they said they could take a more preventive rather than reactive approach. Other reasons given included improved cow comfort through upgrading housing, installation of an automatic footbath, improved ventilation and having a greater knowledge of lameness.

The greatest *negative* impact on the farmers ability to control lameness was Bovine TB and this was the answer given by 10 farmers out of the 14 that provided a response. The reasons for this were constraints around culling of older cows and reduced numbers of youngstock entering the herd. This led to frustration as it became difficult to track progress and monitor patterns in their lameness prevalence following the implementation of changes. Other negative impacts were cited as farm design/layout, heat stress and time.

COSTS ASSOCIATED WITH LAMENESS

During the pre-project survey farmers were asked to estimate the cost of lameness on their farm. Half of farmers were unable to provide a figure commenting that '*they had never thought about it'*, '*it was too scary to think about*' or '*most of the cost I don't see'*. Where a figure was given, this ranged from £10-150 per cow in the herd per year, with an average of £74.

Determining the true costs associated with lameness is challenging due to significant variation depending on the cause, duration of lameness and overall herd performance. Without knowing individual lesion incidence and herd performance data it is only possible to estimate the costs of lameness within a herd. There are a number of different ways that costs can be estimated including using lameness prevalence to estimate annual incidence then using an average cost per case to calculate total annual cost. Alternatively, lameness prevalence can be used to estimate costs based on a cost of £1.50/day for a Score 2 cow and £4.50/day for a Score 3 cow (Atkinson, 2020). Both methods have limitations, especially as they are based on a single mobility score to determine lameness prevalence. The relative risk of lameness is dependent on both season and also time in the management cycle, for example, the first 100 days of lactation is the highest risk period for lameness. Therefore, timing of the mobility score, particularly for block calving herds, will have potentially had an impact on lameness prevalence.

The costs associated with lameness on each farm on a per cow per year basis were calculated based on the costs of a Score 2b being £1.50/day and a Score 3 a/b £4.50/day (Atkinson, 2020). Mild cases (score 2a) were not included in the calculations as although they will have some cost attributed to them, this is less clearly defined in the cost calculations. The results ranged from £10-401 per cow in the herd per year with an average of £191.

The mobility scores at the start, middle and end of the project were then used to identify the cost benefit or deficit per farm over the course of the project. When all 24 farms in the project were considered, the costs associated with lameness reduced by £130,305 across the two

years of the project. The average cost per cow in the herd per year decreased from an average of £191 at the start to £148 at the end, a decrease of £43.

It was not possible to determine the cost of the changes implemented on each individual farm during the project, therefore it was not possible to calculate the return on investment. There are also additional challenges in determining cost:benefit with regard to lameness due to the length of time before a change is expected to have an impact and also the period of time over which it is expected to have a beneficial effect. Due to the fact that a previous history of lameness is a significant risk factor for a cow becoming lame in the future, it can be some time before any changes made have a significant impact on lameness prevalence. There are also inherent difficulties attributing production or performance improvements directly to reduced lameness and determining the impact of changes implemented for lameness on other diseases. Further benefits that are also hard to relate to a 'cost saving' are cow welfare and staff morale.

Change in Costs Associated with Lameness: Control Group versus Intervention Groups

Farms in the Control Group saw lameness costs *increase* by an average of £4.83 per cow in the herd per year over the course of the project whereas those in the Intervention Groups saw costs *decrease* by an average of £64.94. Figure 9 shows the average changes in costs associated with lameness by Group. Within each group there was a large variation between farms in terms of the change in costs associated with lameness, with each group having farms with both positive and negative changes. Therefore, whilst there was a numerical difference between the different groups this was not statistically significant. In Group 2 there were two farms that made considerable improvements in their lameness prevalence which contributed significantly to the effect seen in the group as a whole.

Although there are considerable assumptions and limitations in the way that the costs were calculated, there were a number of farms that saw significant reductions in their costs associated with lameness over the course of the project. However, it is beyond the scope of this project to determine how much of this is directly attributable to the specific method of knowledge exchange or involvement in the overall project.

As expected, due to the way it was calculated, cost saving was directly related to changes in lameness prevalence, however, it was less correlated with the number of changes made during the project. Whilst it may be expected that the farms that made the biggest changes would see the largest cost savings, the impact of changes are not always immediate and, in some cases, can take a full management cycle to have an effect. Therefore, it is likely there will be a continual reduction in the costs of lameness over the coming years as the full benefit of changes implemented is seen.

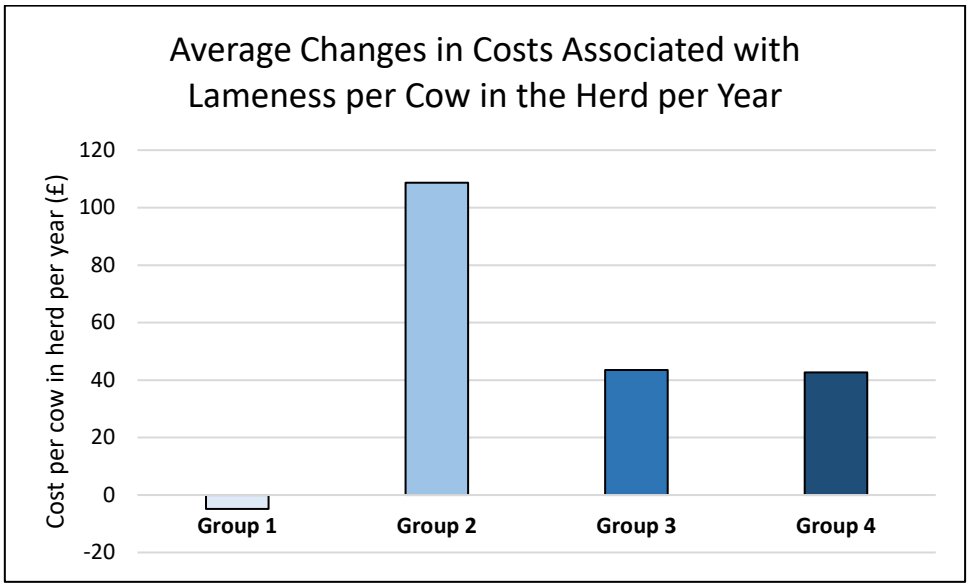

Figure 9: A bar chart showing the average change in costs associated with lameness per cow in the herd per year for farms in each group over the course of the project. There was no statistical difference between groups due to the large range within each group.

IMPACT ON LEVELS OF CONCERN

At the start and end of the project, farmers in the Intervention Groups were asked to rate how concerned they were about levels of lameness in their herds on a scale of 1 (not concerned at all) to 10 (main concern). At the start of the project the levels of concern ranged from 3-10 with an average of 7.7 and at the end ranged from 2-8.5 with an average of 5.3.

Out of the 17 farms, 13 said they felt less concerned, 1 was more concerned and 3 reported the same level of concern. Reasons for being less concerned included a feeling of being more in control, a more preventive approach being implemented and increased confidence in tackling lameness due to improved levels of knowledge. For the farm reporting an increased level of concern, this was due to being more knowledgeable about the impacts of lameness in the herd in comparison to the start of the project.

FEELINGS ABOUT LAMENESS

As well as considering the level of concern around lameness, farmers were asked to describe in one word how they *felt* about levels of lameness in the herd. Farmers in the Control Group reported no change in how they felt about lameness, however, in two cases the farmers said that their level of concern increased after their mobility scoring results were shared with them, as this made them aware of the degree of the problem on their farm.

Nearly all farmers in the Intervention Groups had negative feelings towards lameness at the start of the project, for example they said they were anxious, daunted, frustrated or defensive (Figure 10).

All except for two farmers in the Intervention Groups reported an improvement in how they felt about lameness in their herds by the end of the project, including feeling '*empowered*', '*relaxed*', '*comfortable*' or '*happier*'. The relative change in positivity or feeling towards lameness was not always correlated with the overall change in prevalence of lameness in the herd. Instead, this appeared to be related to a feeling of being in control and a degree of certainty as to the main causes of lameness on the farm.

In both instances where farmers reported feeling more negatively about lameness this was due to herd circumstances, in particular TB which meant that they were either overstocked or unable to cull lame animals due to needing to maintain herd numbers. A summary of the feelings of farmers at the end of the project are shown in Figure 11.

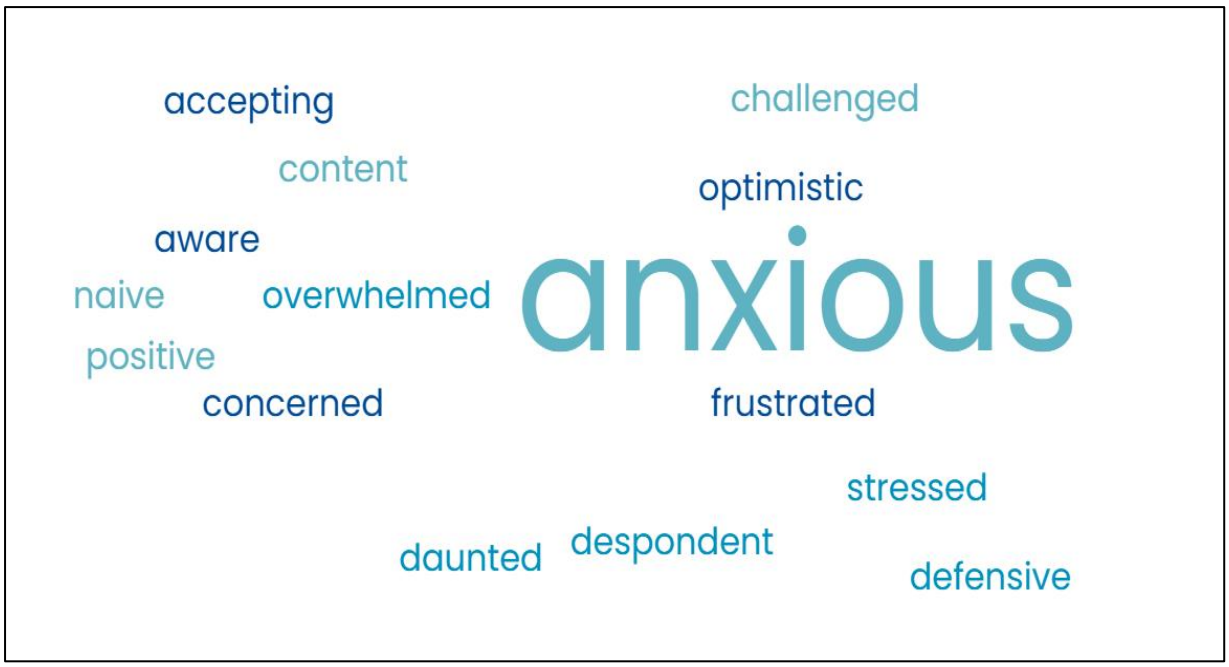

Figure 10: A word cloud summarising how farmers in the Intervention Groups felt about lameness in their herds at the start of the project.

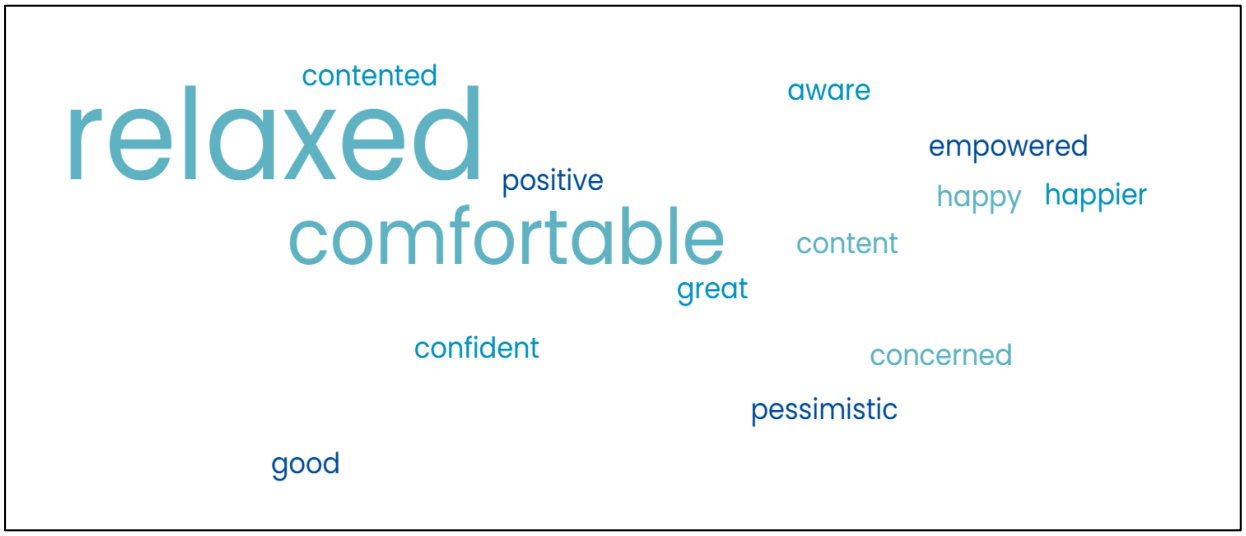

Figure 11: A word cloud summarising how farmers in the Intervention Groups felt about lameness in their herds at the end of the project.

VALUE FROM THE PROJECT

Value and willingness to pay were assessed by asking farmers to rate how valuable they had found the input received during the course of the project in relation to the HFLite and/or FLAGs. This was rated on a scale of 1 to 10 where 1 was rated as of no value at all, up to 10 where it was extremely valuable. They were also asked how likely they were to continue with the HFLite/FLAG now that the project was over on a scale of 1 (not likely at all) to 5 (extremely likely).

HFLite

On average, farmers rated the value of the advice received through the HFLite as 7.8/10 (range 6-10/10). They stated that the most valuable aspect was that it enabled them to focus on one aspect of the farm in detail and to work alongside their vet to do this. A range of scores were given as to the likelihood of continuing with the HFLite (1-5/5) and this was related to how much they valued the advice received. One farm did not provide an answer as the intention was to sell the herd. The majority said it would have been more valuable if the frequency of the visits was increased from annual to e.g., six monthly or if the advice given was *'less textbook and more practical'*.

FLAGs

On average, farmers rated the value of the advice received through the FLAGs as 8.5/10 (range 5-10/10). They stated that the most valuable aspect was visiting other farms, the frequency of the meetings meant they were constantly focusing on lameness and the incorporation of lesion data for benchmarking. All farmers stated that they were highly likely or extremely likely to continue to attend a FLAG in future.

Aspects that would have improved the meetings were improved attendance, more expert input, financial support for highlighted actions and a practical trimming element. The lowest score (5/10 for value and 1/5 for continuing to attend) was given by the farmer who was unable to attend the second round of meetings due to time constraints and therefore was unable to benefit from the additional benchmarking and feedback.

Figure 12 summarises the perceived value of advice and Figure 13 the likelihood that the farmer will continue with the HFLite and/or FLAG.

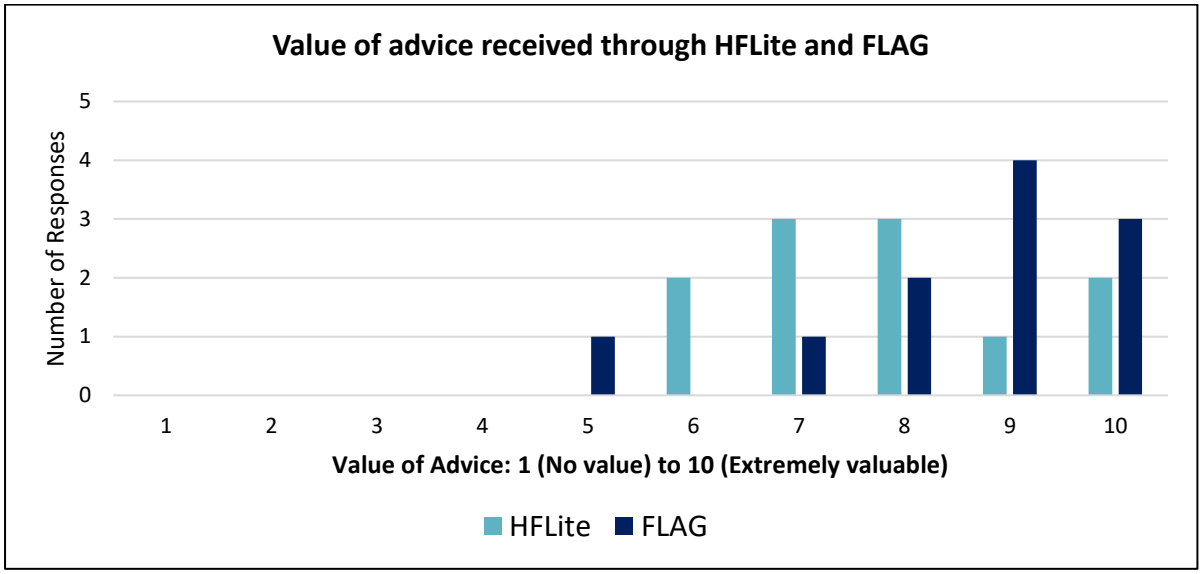

Figure 12: A bar chart showing the value of advice received on a scale of a (no value) to 10 (extremely valuable) for farmers who engage with the HFLite and FLAGs.

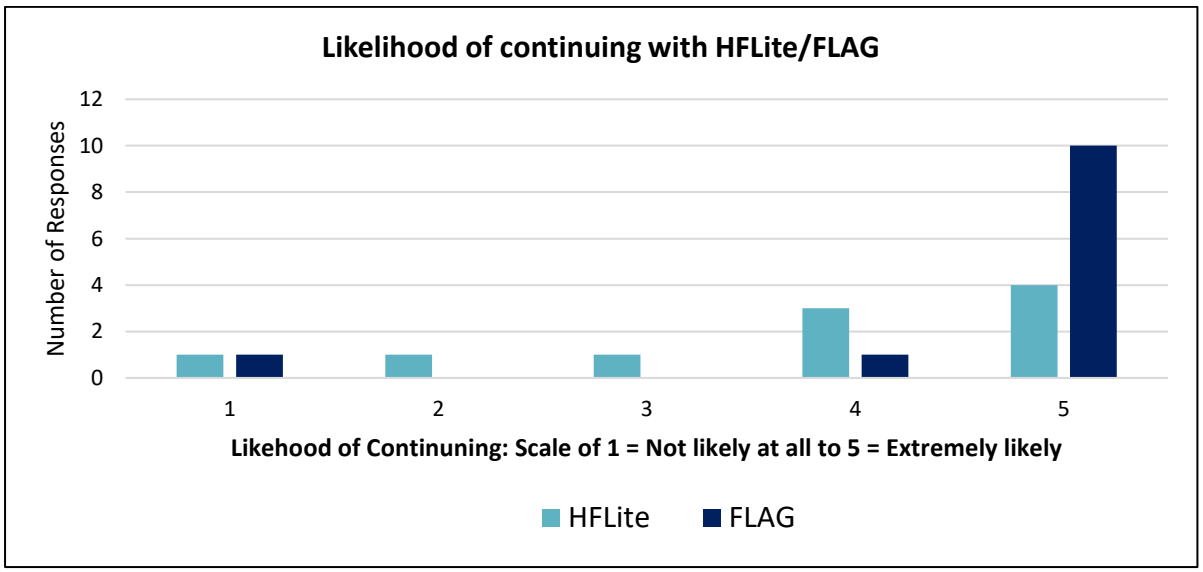

Figure 13: A bar chart showing the likelihood of farmers continuing with either the HFLite and the FLAG on a scale of 1 (not likely) to 5 (extremely likely).

Willingness to Pay

Many farmers commented that they would not have taken part in the project had there been a fee involved, however, releasing the positive benefit to their business changed their view. When asked willingness to pay for the advice received, farmers found this particularly challenging to put a figure to. Of the 16 farmers asked, 14 provided a response. Table 3 shows the average cost *per year* that farmers would be willing to pay for the advice received. Farmers based their calculations on the cost of vet time or how much they would be willing to pay to attend a meeting rather than basing it on herd size or predicted cost savings per cow. As a result, herd size did not appear to influence the amount a farmer was willing to pay.

Six farmers said they would be willing to pay marginally more after learning how their costs associated with lameness had changed over the course of the project.

	Responses	Average (£/year)	Range
Group 2 (HFLite)	4	350	100-550
Group 3 (FLAG)	5	620	200-1,000
Group 4 (HFLite & FLAG)	5	920	500-2,000

Table 3: Figures provided by farmers in the different Intervention Groups when asked willingness to pay for the advice received during the project.

Conclusions

The aims of the project were to explore how different methods of knowledge transfer impacted on their perception of lameness, knowledge and behaviour change. The project identified that farmers vary in their preferences when it comes to learning about or discussing lameness. Whilst some farmers prefer to work directly with their own vet and focus on their own situation, others prefer to work collectively within a group and share ideas through peer learning. However, even when choosing their preferred learning method there was a variation in how much this advice was valued. Ensuring confidence in advice received is important to ensuring actions are implemented, therefore, it is not just the method of learning but also who is involved that is important.

The FLAGs were highly valued by farmers that participated in these. In comparison to the format of a traditional discussion group they found it more useful to concentrate on one specific topic as it ensured a continued focus, and the greater emphasis on practical solutions and peer learning was more beneficial. The action planning element of the FLAGs was also an additional element that helped to drive change and ensure continued engagement.

Farmers also reacted differently to being part of a wider project and how much value they placed in benchmarking of their performance in comparison to other farms. Whilst some farmers found it motivating or encouraging, others were solely focused on their own performance or found it demotivating if they saw others make improvements if they hadn't seen the same progress on their farm.

On average farms in the Intervention Groups implemented more changes in relation to lameness, saw a larger decrease in lameness and a larger reduction in costs associated with lameness in comparison to farms in the Control Group. Whilst this could be expected given the nature of the project, there were clear benefits from farmers actively engaging in discussions around lameness.

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