AGRICULTURAL RESEARCH INSTITUTE OF NORTHERN IRELAND

STRATEGIES FOR REDUCING LAMENESS IN NORTHERN IRELAND DAIRY HERDS

AgriSearch Progress Report
March 2005

AGRISEARCH PROGRESS REPORT – MARCH 2005

Project title:	Strategies for reducing lameness in Northern Ireland dairy herds
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Project Sponsors:	AgriSearch and DARDNI (50% each)

Background to project

Lameness occurs at an average incidence of 24 cases per 100 cows per year in UK dairy herds (Kossaibati and Esslemont, 1996). The cost of an average case of lameness is calculated to be approximately £140 (O'Callaghan, 2002). Therefore, lameness is likely to cost Northern Ireland dairy farmers approximately £10m per annum, which is approximately 10% of the total cost of milk production (The Agricultural Census in Northern Ireland, 2002).

The culling rate of high yielding dairy cows in the UK is estimated to be approximately 25% per annum (Farm Animal Welfare Council, 1997). A recent large scale DARD/AgriSearch survey found that 13.4% of cows culled in Northern Ireland were culled because of lameness (Mayne *et al.*, 2002). Therefore, lameness not only contributes to reduced on-farm efficiency (Webster, 2001), but is also likely to become of increasing ethical concern to consumers.

In view of this background, research to reduce levels of lameness in Northern Ireland dairy cows is urgently required in order to maintain viability and competitiveness. This type of research is also important in terms of creating a "welfare friendly" image of Northern Ireland dairying.

References

Kossaibati, M.A. and Esslemont, R.J. (1996). The prevalence of production diseases in dairy herds. In: *Daisy - The Dairy Information System. Report No. 4 Wastage in Dairy Herds.* University of Reading, pp 63-91.

Mayne, C.S., McCoy, M.A., Lennox, S.D., Mackey, D.R., Verner, M., Catney, D.C., McCaughey, W.J., Wylie, A.R.G., Kennedy, B.W. and Gordon, F.J. (2002). Fertility of dairy cows in Northern Ireland. *Veterinary Record*, 150: 707-713.

O'Callaghan, K. (2002). Lameness and associated pain in cattle - challenging traditional perceptions. In *Practice*, 24: 212-219.

The Agricultural Census in Northern Ireland, Results for June 2003, DARD Statistical Publications.

Webster, A.J.F. (2000). Sustaining fitness and welfare in the dairy cow. *Proceedings of the New Zealand Society of Animal Production*, 60: 207-213.

The financial and welfare implications associated with lameness means that it constitutes a significant problem for Northern Ireland dairy producers. As a result of this, AgriSearch and DARD have agreed to jointly fund a 5 year project aimed at addressing lameness problems.

Project Objectives

(1) To assess the relationship between internal and external hoof structures and the development of solar lesions in dairy cows

(2) To manipulate historical data from ARINI to assess the relative importance of genetic, management and nutritional factors on the development of lameness in cows

(3) To carry out on-farm survey work to identify the main factors preventing farmers dealing with lameness problems at an early stage

Progress in relation to objectives

Objective 1

Solar lesions account for a significant proportion of lameness in dairy cows. Despite 20 years of research, the exact aetiology of these problems remains largely unclear. The most common theory is that solar lesions occur as a result of corium dysfunction in the laminar region of the hoof, or "laminitis". It is thought that this problem is predominantly related to nutritional factors. For example, feeding rations high in concentrates can cause the release of vasoactive substances in the blood, which can lead to alterations in blood supply to the corium and thus reduce its integrity. This loss of integrity may lead to a sinking of the pedal bone within the hoof capsule, causing compression of the solar corium (the layer that produces the hoof horn). This can lead to the production of poor quality hoof horn, which predisposes the animal to problems such as solar lesions. This theory has never been proven, however, and recent research at ARINI suggests that nutritional factors may play a greater role in the development of lameness through external corrosive effects of slurry on the heel.

It has also been suggested that hormonal factors associated with pregnancy and lactation alter the strength of suspensory mechanisms within the hoof. This, in turn, may lead to a sinking of the pedal bone, and trigger the chain of events described above. Recent evidence suggests that lameness problems may also be related to a depletion of fat deposits within the digital cushion area of the hoof. The extent of these fat deposits may be determined by factors such as genetics or body condition.

The aim of this part of the study is to assess which of the following factors has the greatest influence on development of solar lesions:

- Laminitis
- Flexor tendon strength
- Size and fat content of digital cushion
- Level of heel erosion

Hooves from 100 high genetic merit Holstein-Friesian heifers, culled as part of the Brucellosis outbreak, will be used in this study. Prior to the outbreak, these heifers were involved in a study examining the effect of different nutritional regimes (Table 1) during rearing on production performance parameters.

Table 1 Rearing treatments for heifers to be used in dissection trial

Treatment	Target weight at calving	First winter	First summer	Second winter
1	540	Grass silage + conc.	Grazed grass	Grass silage + conc.
2	620	Grass silage + conc.	Grazed grass + conc.	Grass silage + conc.
3	620	Barley straw + conc.	Grazed grass + conc.	Barley straw + conc.
4	620	Barley straw + conc.	Barley straw + conc.	Barley straw + conc.

A number of different measures will be taken during dissection work of internal and external hoof structures. Trial dissection work has commenced on this project. This has allowed us to produce a protocol for dissection work, which is listed below.

PROTOCOL FOR DISSECTION OF HOOVES

Dissection procedures

Both claws of the back left foot and the front right foot to be used in dissection

1. External description of hooves

For each claw:

- Record perpendicular height of heel, overgrowth of toe and axial wall deviation (as illustrated by Murray *et al.* (1994). However, do not record scores for perpendicular height of heel and overgrowth of toe but actual measurements.
- Record the length of sole (from the back of sole to tip of toe, and the length of the toe (from the top of the coronary band).
- Measure the width of the heel (for each individual claw)
- Sole lesion and heel erosion scores should be recorded using the method reported by Livesey *et al.* (1998). In this system the planter surface of each claw is divided into six zones. Zones 1 to 3 make up the white line, zones 4 and 5 the sole, and zone 6 the heel.
- Examine the wall of the hoof for 'hardship bands', i.e. obvious indentations that occurred as a result of challenge to the animal. The number of hardship bands on each claw, and their distance in millimeters from the bottom of the coronary band should be recorded.
- Take a digital photograph of the sole of the hoof – all photos should be taken from a standard distance and a ruler should be evident in the photo as a guideline. This will be used to determine solar area.

2. Dissection procedures (from Lischer *et al.*, 2002)

1. Using the band saw, cut the foot two centimeters above the top of the coronary band

2. Use the band saw to separate the claws

3. Each claw to be dissected as follows:
   - Draw a line at right angles to the longitudinal axis of the claw from the caudal edge of the axial horn wall
   - Draw a second line at right angles to the longitudinal axis of the claw at the widest point of the heel
   - A Sagittal Section should be cut along the mid point of both of these Lines

Use the axial (inner) half of the claw to make the following measurements:

1. Measure the total thickness of the soft tissues between the pedal bone and the inner surface of the horn capsule, and between the pedal bone and the outer surface of the horn capsule (i.e. the sole). Carry out these measurements at the tip, the middle and the caudal edge of the bone

2. In addition, measure the depth of digital cushion, corium and sole at points T1, T2, T3 and T4
   - T1 equals a point 1.5cm proximal to the tip of the pedal bone
   - T2 is mid-way between the tip and the caudal edge of the pedal bone
   - T3 is the caudal edge of the pedal bone (Tuberculum Flexorium)
   - T4 is at right angles to the heel surface and through the middle of the sesamoid bone

3. Take a digital photograph of the inner surface of the axial part of the hoof (make sure all photos taken at standard distance with ruler in the photo for reference)

4. Record any evidence of bruising to the sole of the hoof (on both axial and abaxial sections of the hoof), including location, depth and width of bruising

5. Dissect out 2cm of the flexor tendon from its sheath from each claw at the point where the tendon meets the pedal bone. Place in storage tube, label with animal number and claw number, and re-freeze to –20°C

6. Realign both sides of the claw and cut transverse sections at T1, T2, T3 and T4 (having marked these points on the outer part of hoof wall)

7. Realign the axial and abaxial segments of the different sections, and examine them on their proximal surface.

8. Where sections of the three fat cushions are evident (there should be three fingers of fat running on the undersurface of the hoof), their maximum length and width should be determined.

9. Take a digital photograph of the proximal surface of each of these sections

10. Take a sample of fat (3 mm cube) from the middle and two widest points where digital cushion tissue is visible. Make note of where samples were taken from (in terms of distance from both outer sides of the claw). Put samples into storage tubes, label with animal number, claw and section, and refreeze to –20°C. These will eventually be analysed for fat content and fatty acid profile.

11. On sections T1, T2 and T3 measure the degree of displacement of the pedal bone and deformation of the claw capsule. This is determined by measuring the difference in levels between the inner angle of the axial wall (original position of the corium) and the apex of the bulge of the corium under the pedal bone (maximal displacement) (see Lischer *et al* (2002) paper, Figure 3)

12. In addition, measure the distance between the bottom the pedal bone and the inner part of the horn capsule, and the outer wall of the horn capsule (the sole). These measurements will be taken at the middle and both outermost points of the pedal bone.

A sub-section (1 cm thickness) of the T1 section (on the frontal abaxial part of the hoof) will be removed and kept for preparation for microscope analysis. Cell structures will eventually be assessed at points x, y and z on Figure 2. The subsection to be placed in a storage tube labeled and refrozen to –20°C.

References

Lischer, C.J., Ossent, P., Raber, M. and Geyer, H. (2002). Suspensory structures and supporting tissues of the third phalanx of cows and their relevance to the development of typical sole ulcers (Rusterholz ulcers). *Veterinary Record*, 151: 694-698.

Livesey, C.T., Harrington, T., Johnston, A.M., May, S.A. and Metcalf, J.A. (1998). The effect of diet and housing on the development of sole haemorrhages, white line haemorrhages and heel erosions in Holstein heifers. *Animal Science*, 67: 9-16.

Murray, R.D (1994). Observer variation in field data describing foot shape in dairy cattle. *Research in Veterinary Science*, 56: 265-269.

Objective 2

Two projects have been chosen for initial data manipulation, and findings to date are listed below:

Project 1

This project involved rearing 100 heifers on one of four different nutritional regimes (Table 2) at Hillsborough from approximately 7 weeks of age until prior to calving at 2 years of age.

Table 2 Nutritional treatments applied during rearing in Study 1 of Objective 2

Treatment	Target weight at calving	Diet Type			
		First winter	First summer	Second winter	Second summer
1	540	Grass silage + conc.	Grazed grass	Grass silage + conc.	Grazed grass
2	620	Grass silage + conc.	Grazed grass + conc.	Grass silage + conc.	Grazed grass + conc.
3	620	Barley straw + conc.	Grazed grass + conc.	Barley straw + conc.	Grazed grass + conc.
4	620	Barley straw + conc.	Barley straw + conc.	Barley straw + conc.	Grazed grass + conc.

At this stage, heifers from each nutritional treatment were allocated one of 11 different farms where they remained for their first and second lactation. A number of different sires were represented within each treatment, on each different farm.

Lameness records, in terms of lesions to the sole of the hoof, were recorded during the first and second lactation.

This is a unique data set which allowed us to investigate the *relative* importance of factors such as nutrition during rearing, farm effect, sire effect, lesions to the hoof prior to calving, and body weight at calving on development of lameness problems. These factors were assessed using regression analysis.

The results showed that in the first lactation (Table 3), the two main factors causing variation in lesion scores were "farm" and "sire", although neither effect was significant.

In the second lactation (Table 3), the main factor accounting for variation in lesion score was "sire", which accounted for more than 30% of the variation in lesion scores. These results suggest that genetic effects are more important in determining lameness problems that farm effects. Factors such as nutritional treatment during rearing, body weight at calving and lesion score at calving did not appear to have an effect on development of lameness lesions in this study.

Table 3 Percentage of variation in solar lesion scores at 3 months post calving associated with different factors

Lactation	Factors	% variation	Significance
1	Farm	18	NS
	Sire	19	NS
	Nutrition during rearing	1	NS
	Liveweight at calving	1	NS
	Pre-calving hoof lesion score	1	NS
2	Farm	20	NS
	Sire	36	<0.05
	Nutrition during rearing	4	NS
	Liveweight at calving	2	NS
	Pre-calving hoof lesion score	0	NS

The sire effects could possibly be mediated through differences in foot size and shape, or through differences in milk yield. Unfortunately foot conformation measures were not taken in this study, however milk yield data available and are being added into the analysis.

Project 2

In a similar design to Project 1, 100 heifers were reared at ARINI on one of four different nutritional regimes (Table 4) from approximately 7 weeks of age until prior to calving at 2

years of age. These animals were not returned to different farms, however, but remained at ARINI throughout their first lactation.

Table 4 Nutritional treatments applied during rearing in Study 2 of Objective 2

Treatment	Target weight at calving	Diet Type			
		First winter	First summer	Second winter	Second summer
1	540	Grass silage + conc.	Grazed grass	Grass silage + conc.	Grazed grass
2	540	Barley straw + conc.	Barley straw + conc.	Barley straw + conc.	Grazed grass + conc.
3	620	Grass silage + conc.	Grazed grass + conc.	Grass silage + conc.	Grazed grass + conc.
4	620	Barley straw + conc.	Barley straw + conc.	Barley straw + conc.	Grazed grass + conc.

At regular intervals throughout rearing and first lactation, detailed measurements were taken of hoof size and shape, in addition to measurements of solar lesions. These included measurements of solar area, heel height, toe length, overgrowth of toe, and axial wall deviation.

This provided us with a very full dataset, which will allow us to determine a number of factors:

1. When are the key lameness problems likely to occur during first lactation?
2. What is the relationship between foot size and shape, and development of lesions?
3. Is it possible to predict lameness problems during first lactation from parameters measured during rearing?

In relation to the first factor, Figure 1 shows average levels of lesion scores during rearing and first lactation.

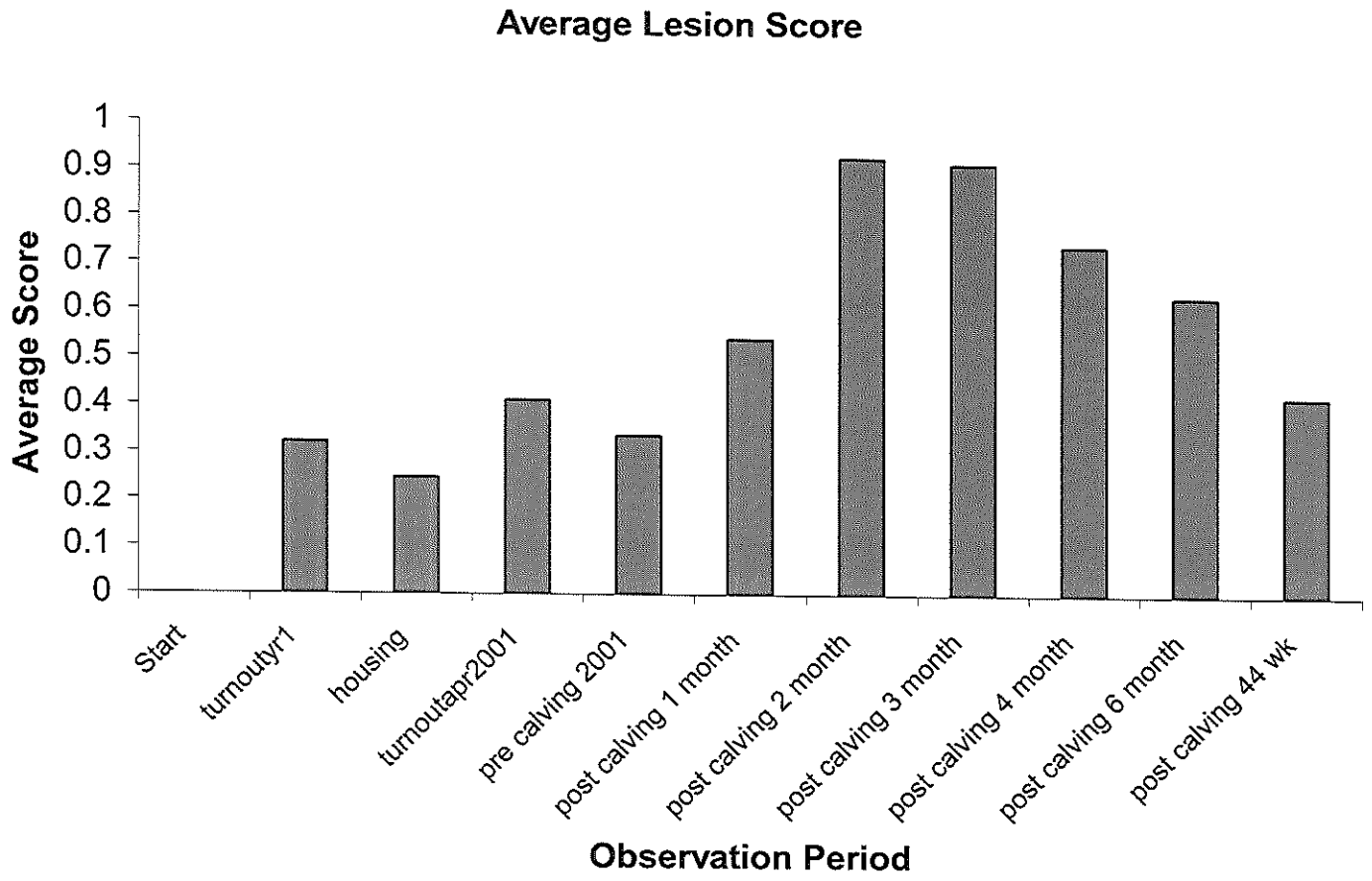

Figure 1 **Average solar lesion score at different stages during rearing and first lactation**

As we would have expected, lesion scores show an increase after periods of housing. Peak lesion scores are shown in the second and third month post calving. Due to rate of hoof growth, damage to the sole of the hoof normally becomes apparent after about 8 to 10 weeks. Therefore the damage that was shown in the second and third month post calving actually occurred around the time of calving. This provides further evidence that management at the time of calving is crucial in terms of preventing future lameness problems.

Correlation analysis was carried out to assess the relationship between lesion scores and foot conformation measurements.

The factors that were most consistently related to development of solar lesions were were solar area ($r=0.312$, $P<0.05$ at 1 month post calving, and $r=0.620$, $P<0.05$ at 3 months post calving) and heel erosion ($r=0.271$, $P<0.05$ at 1 month post calving; $r=0.310$, $P<0.01$ at 2 months post calving).

These findings support the theory that cattle with large, shallow hooves are more prone to suffer heel erosion and solar lesions, however further, more sophisticated analysis is required. These data are currently being reanalysed by discriminative analysis. In this analysis animals will be split into three factor groups: no lesions, some lesions and significant lesions. Differences between these factor groups in foot conformation parameters will be assessed.

Stepwise linear regression was also carried out to assess whether factors measured during rearing (for example foot size and shape at 6 months of age) could be used to predict lameness problems during first lactation. No consistent predictor of lameness has been identified as yet, however analysis is ongoing.

Objective 3

It is widely recognised that one of the main factors contributing to lameness problems on farm is delay in treating the problem. There are four main reasons why this delay may occur:

- Difficulty identifying different types of lameness and causal factors, and suitable treatments (Knowledge)
- Lack of awareness of lameness problems on farm (Perception)
- Lack of time, money or equipment to deal with the problem (Time/money)
- Prioritising other areas of management (Attitude)

In order to target relevant advisory programs, information is urgently required on the main factors preventing farmers dealing with lameness.

As part of this project, research will be carried out which involves on-farm survey work of approximately 60 dairy farms in Northern Ireland. The survey will involve a 1-hour interview with the farmer using a questionnaire. After this interview the herd will be locomotion scored.

The farms to be included in this survey will be selected to be as similar as possible in terms of herd size and system of management. Previous research carried out by the School of Psychology involved postal surveys to dairy farmers. These surveys recorded a number of factors relating to the farm such as herd size, breed, concentrate input per cow/year, number of staff etc. Three hundred and sixty-one of these surveys were returned, and it is proposed to select 100 farms initially from this dataset for survey work (with a view that 60% of farmers will agree to the survey). All farms are registered pedigree breeders.

The selection criteria for the farms have been determined as follows:

- herd size of 100 to 200 cows
- predominantly owner occupied
- Holstein/Holstein Friesian
- $\geq$6500 litres per lactation
- winter/year round calving herds

This survey work is to take place between Autumn 2005 and Spring 2006. An initial draft version of the survey questionnaire has been produced and should determine knowledge, perception, time/money, and attitude factors. This Questionnaire is attached in Appendix 2.

It is also proposed that farmers participating in this survey be invited to participate in a workshop/seminar on lameness in April 2006.

APPENDIX INITIAL DRAFT AREAS TO BE INVESTIGATED IN SURVEY

Farmer asked to pick from a list the foot problems those most commonly encountered on farm

At end of interview the farmer is presented with 8 pictures of common lameness problems and asked which he had seen on farm and to name them:

Score of 0 = recognizing condition and naming it correctly
Score of 0.5 = recognizing condition and getting it nearly correct
Score of 1 = recognizing the photo, but not knowing correct name
Score of 2 = not recognizing it and getting name completely wrong

Farmer asked to rank knowledge on lameness

(1) Adequate
(2) Inadequate

Level of agricultural training will be determined from following categories:

- Degree
- Higher national diploma
- Certificate
- Courses
- Focus farms
- None

PERCEPTION/AWARENESS

Farmer asked to estimate how many cows are lame in the herd that day

Farmer asked to score pain associated with lameness (0 to 10 for different types of lameness)

Farmer asked to rank how much of a problem lameness is in the herd:

(a) not a problem
(b) moderate problem
(c) large problem

Farmer asked how they recognize lameness on farm:

- Limping
- Not entering parlour
- Other

Farmer asked how often he checks for lameness?

If lameness is a problem, farmer asked why is it important? Following options will be ranked in order of importance:

(a) time consuming
(b) welfare of cows
(c) vet expenses
(d) reduction in milk yield
(e) loss of body condition
(f) reduced fertility
(g) others

Farmer asked how long they normally wait before treating lameness cases:

(1) immediate
(2) 1-3 days
(3) 1 week
(4) 2 weeks
(5) longer

Farmer asked whether cows are normally treated by farmer or vet

If delay in treatment is evident, what factors cause it?

What type of lameness is treated more urgently

(1) dermatitis
(2) ulcer
(3) foul
(4) etc

Farmer asked what routine measures are used to prevent foot problems, i.e. foot trimming, foot bathing

Farmer asked what equipment is available for lifting/examining feet

Farmer asked to list the following 5 problems in order of economic importance on the farm

- calf scour
- calf pneumonia
- lameness
- mastitis
- infertility

Farmer asked which of the following factors are the main risk factors associated with lameness on the farm:

(a) cubicle comfort (size/bedding)
(b) stony tracks
(c) nutrition/feeding
(d) wet conditions/slurry
(e) selection of sires
(f) concrete: broken/rough and slippery

Farmer asked whether cubicle accommodation on farm is adequate

- Yes
- No
- (if no specify why not)

Farmer asked to rank sources of information on lameness

- Popular press
- Farmers meetings
- Advisors
- Vet
- Retailers/reps
- Others (specify)