Lameness Prevention in Dairy Cows

By

Jo Speed

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Acknowledgements

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Disclaimer

This report represents the results of my study and the opinions expressed are my own and are not necessarily those of the Nuffield Farming Scholarship Trust or any of the other parties.

About the Author

I was born in Sheffield, and, after ruling out becoming a vet, I decided I was going to go and milk cows in Wales, most people thought I was insane. This was in 1986, and I have been involved in agriculture and the dairy industry since then.

Lameness is a topic that I have been passionate about for the last 10 years; it is this underlying passion that drove me to apply for a Nuffield Scholarship, and resulted in my being awarded a scholarship. Initially lameness and foot trimming were a large part of a job requirement, when I lived in Portugal and was part of a team managing a 1000 cow unit. However, I quickly realised that the issue was more than a tick box task it was a big management issue, and relied as much on prevention as cure.

After three years in Portugal, I returned to the UK to Harper Adams University College, and graduated with an honours degree in Agriculture with Animal Science. Having focused my dissertation on cow behaviour and cow handling on tracks, and their link with lameness, I was hooked on the subject, and knew it would be something I would continue to pursue. At the time, research in this area was limited, but more recently, cow behaviour and cow flow and a proven and intrinsic piece of the jigsaw in the fight against lameness.

After graduation, I joined a dairy consultancy firm for three years before starting work for Dairy Co, with whom I have been employed for 8 years. I was one of the first Extension Officers employed by Dairy Co, a role developed in 2002 that was new to both the organisation and UK agriculture.

The Nuffield journey was a challenging and exhilarating year for me, made all the more challenging by the fact that I did all of my travelling whilst pregnant. The rewards I reaped, however, are and have been many.

A mind is like a parachute -it doesn’t work unless it’s open

Executive Summary

When I began the study I was quite specific on the areas I wanted to cover, mainly the key prevention and recording strategies used overseas to prevent lameness, and how this knowledge was used to benefit the industry, with regards to technology transfer. However, whilst I was travelling I realised quite quickly that this was not a one stop shop of solutions, and that the provision of management advice to dairy farmers varies greatly across the globe. The key problem is that we are dealing with three diseases in lameness and, not just one disease and unlike the 5 point mastitis plan, there is no one system in place in the industry that allows farmers to identify key areas and develop an action plan. The advice is generally commercially driven and fragmented and doesn't allow farmers to appraise their system to see not only which lameness problem they are dealing with, but how to prevent it in the future.

Lameness is high on the agenda with regards to animal welfare, and surprisingly the UK is not the best in the world, neither are we the worst. When I started this scholarship, I thought the UK would have the highest standards of welfare across the world, but findings show we are not the best, nor are we the worst. To approach this in a balanced way, it can only be measured by calculating the amount of injuries associated with lameness on farm.

As a result of my Nuffield Scholarship, one of my key objectives and recommendations was to develop a lameness programme which could be used to assess farm systems, identify problem areas and offer key areas where real improvements in lameness levels would be seen if the farm implemented the recommendations. As I will discuss later in the report, there are already programmes across the globe that does exactly this, but they are either commercial programmes or research programmes of specific to a particular countries issues, for example New Zealand. Dairy Co is currently looking at developing a lameness programme of this nature.

There are a number of tools available, that identify lameness at an earlier stage, and this is the second key finding from my study. If cows can be identified before they actually have impaired ability to walk normally, the benefits seen from a cost and welfare point of view are tremendous and measurable.

I decided to use the time I had to focus on Canada and USA, because they have cutting edge world class research on animal health and welfare. I also met with

a number of other contacts in Finland and the UK, including Neil Chesterton, a vet from New Zealand who focuses on lameness and cow behaviour and has developed the Healthy Hooves project, which I will discuss in further detail in the report. Attending the International Lameness Conference in Finland, also allowed me to meet the top researchers, scientists and contacts from across the globe.

Background on Lameness

Lameness in dairy cows in the UK is at unacceptably high levels, and has been cited to range from 3% upwards to 40% incidence, causing economic loss to the industry, the farmer and poor welfare for the cow. Research shows lameness reduces productivity at peak yield by up to 20% and with an estimated cost of around £178 per case, it is an area we overlook at our peril. Lameness is third on the list when citing reasons for culling cows.

Animal health and welfare are consistently identified as a major cause of consumer concern associated with livestock agriculture; the sector must strive to meet the expectations of its customers.

Chris Brown the head of technical and sustainable sourcing spoke at the 2009 Cattle Lameness Conference (CLC), putting the milk market into perspective, from a consumer angle. 99% of households buy milk every 5 days, averaging 2.61 litres per trip, and totalling 3.5% of their total grocery spend.

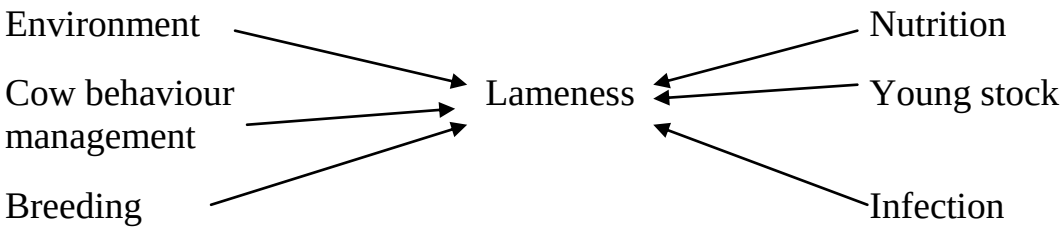
- The challenge for the livestock industry is that when surveyed 88% of their customers thought that the industry was profit driven and not customer driven, and 75% agreed with the following statement “the UK food industry puts profit before health”

David Logue quotes in one of his papers that “research into lameness has, it seems been less co-ordinated than other areas such as mastitis, and the result is that there are inconsistencies in approach and gaps in our knowledge, and this has made interpretation of literature concerning risk factors difficult, and caused problems in developing the most appropriate cost-beneficial advice for the industry”. I certainly agree with these sentiments.

I am writing this report with my mind in 2 camps, as an ex dairy farmer and an extension officer, therefore my aims are to provide a comprehensive but simple approach to my findings and recommendations in the highly complex area of lameness prevention. I am not a scientist, but I aspire towards a technical, honest and informative report.

Lameness Overview

What is lameness? The best definition is any abnormality that causes the cow to change the way it walks (its gait). Therefore lameness can be caused by a wide variety of foot and leg conditions, be they disease, husbandry or environmental factors.



Lameness is a real issue on UK dairy farms, a survey by Whitaker *et al* in 2004 found that incidence ranges/ 100 cows/ year ranged from 2.1% on the best farms to 46% on the worst. In 2005 the average cost for a case of lameness was put at £178 and more recent data suggests an average of £240. On a worst case scenario with a 40% incidence this would be a direct cost of £9600/ 100 cows/ year.

University of Warwick found on average a 390 litres milk loss per lactation yield reduction with a case of lameness, and with solar ulcers this increased to 570 litres. This milk loss starts 4 months before treatment, leading back to one of my recommendations that we need to identify these lame cows earlier.

High lameness prevalence is associated with:

- Poor hygiene and limited space per cow during housing leading to a build up of slurry and increased likelihood of infectious diseases
- Collecting yards and cow tracks can cause excessive trauma on soles if managed incorrectly and overstocked
- Poor handling of cows during milking and routine movement
- Incorrect cubicle dimensions and design for the type of cow in the system can cause trauma leading to hock lesions and solar bruising.
- Management of cow diets
- Genetics
- Environmental stress caused by surfaces both in cubicles and on concrete being incorrectly managed or designed
- Excessive or insufficient wear of soles

Most economic losses due to lameness results from costs of:

- Reduction in milk yields
- Reduction in reproductive performance and prolonged calving interval
- Increase in involuntary culling rates and premature culling
- Discarded milk
- Additional labour cost and time to care for lame animals and cost of veterinary treatment

From a welfare point of view there is increased pain and discomfort, as well as the increased risk of culling due to reduced milk production and reduced reproductive efficiency.

New laws at the beginning of April 2007 detailed that if you are not health planning than you may be in breach of the law, and this may become statutory, it is important that we have a planned approach in prevention of this disease, whilst laws are voluntary rather than statutory. As part of the five freedoms, this law also states that animals should have "freedom from discomfort" and "freedom from pain, injury and disease- by prevention or rapid diagnosis and treatment".

Herd performance losses associated with lameness include reduced body weight and condition, reduced feed intake due to reduced mobility, reduced milk fat secretion and inverted fat: protein ratios due to acidosis, decreased longevity in the herd and poor reproductive performance. Laminitis can also cause a reduction in feed intake that predisposes the cow to other problems such as displaced abomasums and ketosis.

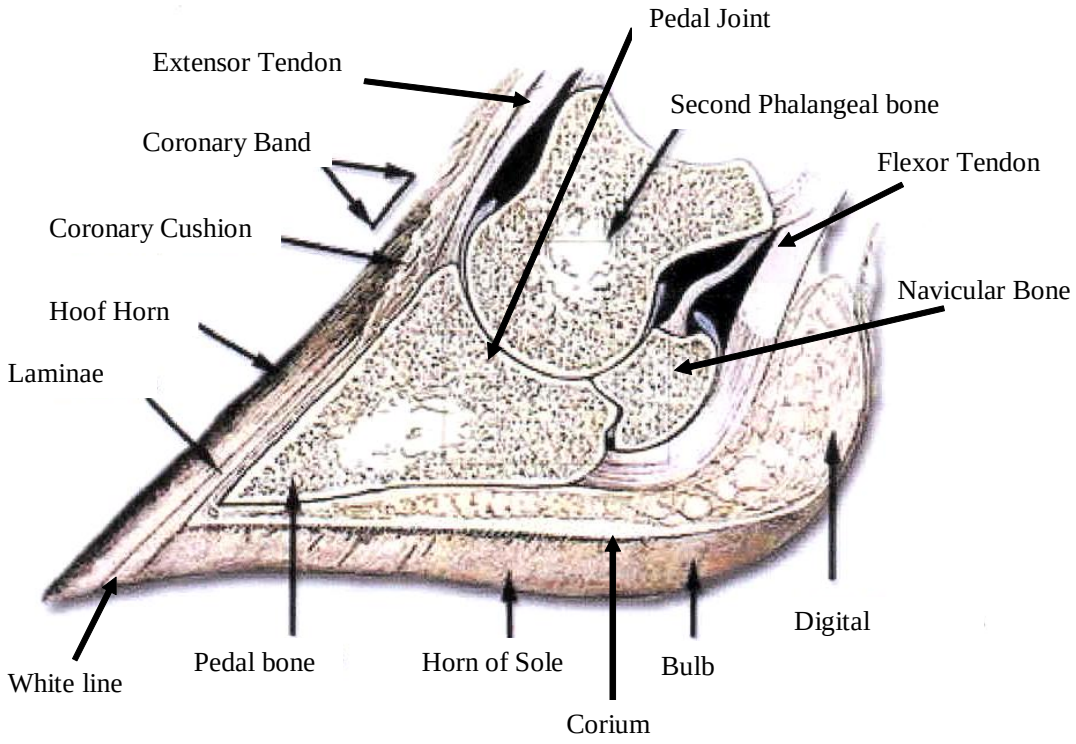
Appendix 2 details key lameness risk factors in dairy herds.

On farm observations in Canada and US suggested that the most common causes of lameness are:

- Walking on abrasive surfaces predisposing to excessive wear on soles of feet
- Insufficient lying time in cubicles caused by too much time spent standing on concrete

Common causes of lameness

Table 1: Structure of a cow's foot



Lameness is an extremely multifactorial disease to deal with, and just to make it harder it is really a set of specific conditions that contribute to overall lameness:

- Problem originating from the claw horn (e.g. solar ulcers)
- Problems originating from the skin bordering the claws (e.g. digital dermatitis)
- Lesions or conditions causing lameness that do not originate from the foot (e.g. hock injuries).

Infectious diseases including foot rot and digital dermatitis (DD), are contagious diseases and are usually caused by the environmental problems such as slurry pooling caused by poor slurry management, and cows walking outside in wet, muddy conditions. Control is with antibiotics, hygiene and regular foot bathing.

It is estimated that 20% of all lameness can be attributed to DD, and not just a unique problem to the UK, with over 90% of herds affected in Wisconsin.

Digital dermatitis, once on a farm can be controlled, but not eradicated; a routine treatment to fully meet the DD challenge is the most positive approach a farmer can take, if they have a constant challenge with this infection.

Foot rot is a deep infection, within the tissues encapsulated by the hoof horn, by *fusiformus* bacteria. The foot often swells, and deep cracks can develop, in severe cases the joint capsule will become infected, and infection will spread up the leg.

Heel erosions occur when the normally smooth bulb of the heel becomes pitted and ridged from constant bacterial assault and infection. These are more apparent when cows are walking through wet, muddy areas which then weaken the epidermis and allow bacteria to penetrate. Treatment is with antibiotics and regular foot bathing.

Solar Ulcers are caused by the bruising of the corium that interrupts horn formation. They are caused by a number of things including:

- Laminitis
- Rumen acidosis
- Unnecessary standing on hard floors, primarily because lying spaces are insufficient (lack of cubicles, wet floors and inability to access cubicles)
- Insufficiently comfortable (depth of bedding, type of bedding and size of stall in relation to size of the cow)
- Queuing for water, feed and to be milked

For these reasons they are usually found on the inner side of the outside hind claw. They can also be caused by incorrect hoof trimming or lack of trimming.

White-line separation occurs when the junction between the horn of the sole and the wall is disrupted, often characterised by laminitis type damage to this junction and hoof wall. This causes the connecting hoof horn between the sole and the wall to wear away faster and/ or be penetrated by foreign bodies such as stones. Walking and twisting actions and soft wet horn contribute towards this, but there are no studies to show that this lesion can be prevented.

Laminitis is an inflammation of the soft tissue of the hoof (lamellae) that results in pain and abnormal development of hoof horn and can lead to solar lesions. Essentially it is a disruption of the blood supply to the corium, which produces hoof horn. It can be caused by imbalanced diets, with an incorrect balance between forage and starch concentrates (too little forage combined with too much starch), and post calving from change in diets. But can also be caused by management factors such as slippy, hard flooring.

Claw imbalance can be caused by incorrect foot trimming leading to incorrect weight bearing. It can also be caused by misshapen feet, such as a corkscrew foot or an injury which causes one claw to grow faster than the other.

Upper leg injuries are generally caused by cows slipping and falling, either via cow pecking order or aggressive handling.

Hock Injuries are caused by abrasion on the cows lying surface. Cornell University developed the following hock score guide as an assessment of cow comfort, giving visual indicators and guidance on assessing if hock damage is a big issue.

Table 2: Cornell Hock Assessment Chart for Cattle

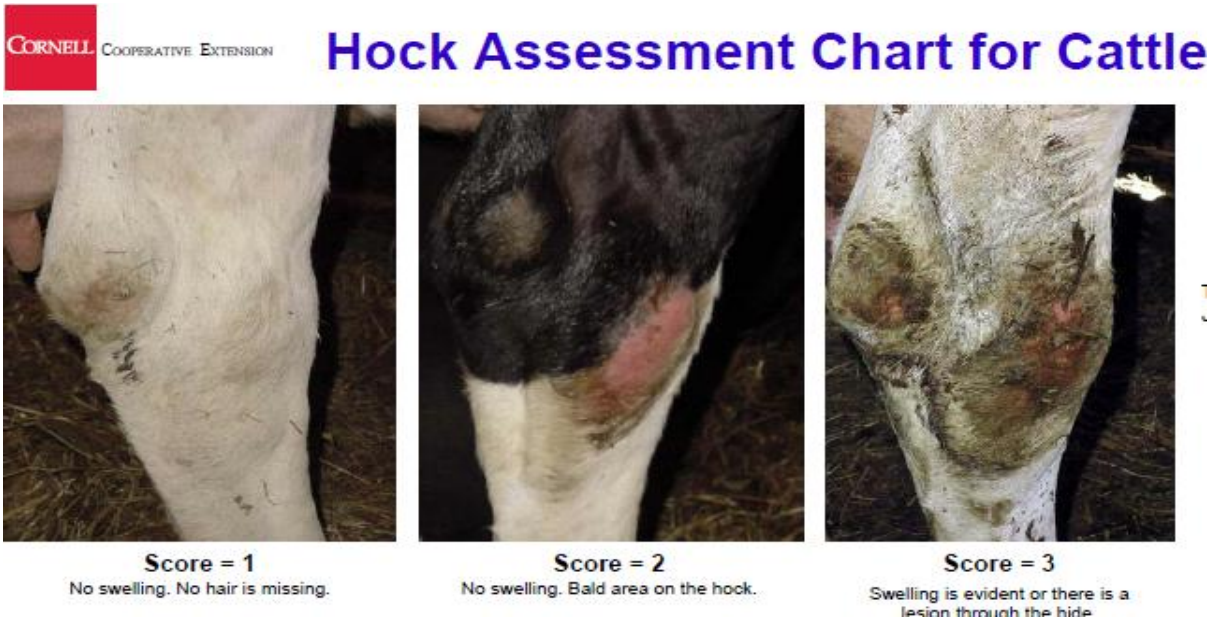


Table x: Cornell hock assessment chart for cattle

Husbandry factors

The main husbandry factors involved with dairy cattle lameness are:

- Environment
    - Cubicles
    - Straw yards
    - Passageways and collecting yards
    - Management of slurry
    - Handling facilities and flooring
- Handling dairy cows
    - Cow tracks
    - Cow comfort, cow flow and cow signals
    - Collecting yard and milking parlour management
- Nutrition
- Youngstock management
- Genetics

As you can see there is a large section on environment, and I think this reflects my own personal opinion that the environment has the biggest role to play. All the sections here play an intrinsic role, and if one area isn't managed well, it

will impact herd health in some way. USA and Canada seemed to focus a lot more on environment and cow comfort, than in the UK, having realised the associated losses. In New Zealand the cows are walking long distances on cow tracks, and the biggest impact the farmer can have is to look at how they handle their animals and the impact of this on animal health. These areas are covered in depth in this section.

Environment

Cow comfort is key, and the area the cow rests in is important when considering lameness. A cow that spends less time lying down is likely to spend more time lying in passageways, loafing areas or feed fence, and therefore more likely to develop foot related problems.

Cubicles

In USA most cubicles have a mat or mattress with a coating of sawdust, or more frequently on deep sand beds or sawdust beds, these were in the main large cubicles focused on cow comfort. The bedding materials used, tied in well with new technologies that I saw being used, such as slurry separating reusing sand bedding, and anaerobic digesters and making more use of resources and for the production of electricity.

In North America and Canada some cows are still in tie-stalls, tending to be in wet areas and smaller herds, these are labour intensive systems.

The dimensions of a cubicle are dependent on the size of the cow (chest girth and diagonal body length), this is best estimated using body weight, dimension as shown in appendix 3.

- Base cubicle design on cow size, space sharing principles and cow lying and rising behaviour
- Non abrasive surface
- 5% more cubicles than cows should be provided in any management group
- Fitted with a brisket board
- Research in USA shows cubicle usage increases with cubicle size, so it needs to provide body space, head space and lunging room

Lunging room should also be adequate for the size of cow (appendix 4). When a cow rises from a lying position, she lunges forward to transfer the weight from her hindquarters onto her front legs. Observations have shown that a cow requires between 0.7 and 1.0 metres of space in front of her to rise easily. If the lunging space is restricted, she will have difficulty in rising, putting more pressure and trauma onto the sole of the foot.

Straw Yards

Straw yards are most commonly seen in Europe, and very few would be seen in USA. Minimum area allowances can be found in appendix 3.

- Distance from lying area to feed area should be less than 10 metres
- Correct stocking rate for area
- Do not position water troughs in bedded area

Passageways and collecting yards

Poorly designed and maintained concrete yards can cause sole and hoof damage. Conversely abrasive floors such as new concrete can also cause sole injury. I did some training with Joep Driessen from Holland on Cow Signals, and he suggests doing the "ballerina test" to ascertain how slippy the floor is, if we can slip on it so can the cows.

Management of Slurry

Slurry pooling in yards can be prevented by fixing areas of broken concrete and when laying new concrete, ensure the floor has a fall of around 2% (1:50) to assist drainage of slurry.

Slurry pools can harbour infection such as digital dermatitis. At the Cattle Lameness Conference in 2009, Dr Stuart Carter suggested that early results from their dermatitis trial, suggested that the *treponemes* (the organism most frequently detected and reported in digital dermatitis tissue) hadn't been isolated from slurry/ dirty areas in housing systems. Their early findings suggested that the main source of infection was the lesion itself, and not the slurry or poor hygiene, in which case the transmission route would need to be broken and/ or specific antibiotics identified.

Handling facilities and flooring

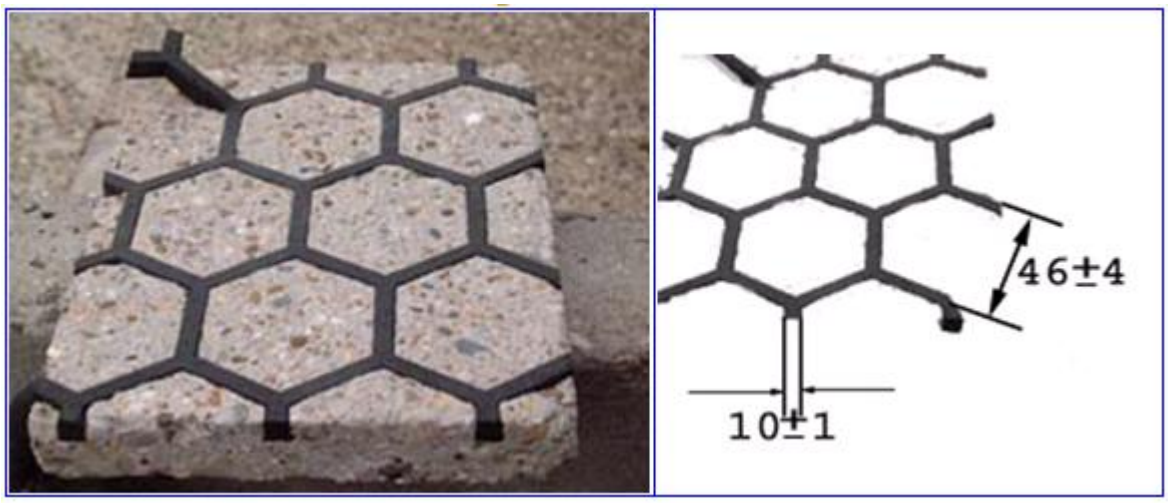
In USA Temple Grandin has done a tremendous amount of work on handling cattle, and this has been utilised all over the world, with proven benefits. Obviously how cows are handled has an impact on the stress and trauma of the sole of the foot, and poor handling can lead to excess trauma. Common distractions to avoid in handling cattle are:

- Bright light, such as blinding sun. Animals will move from a darker place to a lighter place, but will not move towards blinding light.
- Changes in flooring type and texture will cause problems as will sharp corners
- Non-slip surfaces. Slipping can lead to bruising of the sole, and other foot and leg damage

All concrete surfaces which cows walk on should be easily cleaned and provide adequate traction without being excessively abrasive. Poorly designed and maintained concrete floors can cause considerable sole and hoof wall injury. Ideally flooring should be:

- Cut grooved 40mm apart at right angles to cow flow
- Grooves should be 6-10mm deep and 10mm wide
- Grooving at right angles better than parallel, the best systems I saw in the States used this technique
- Floors should be laid with a fall of 2% and 3% through the length of the building
- Free of projections and sharp edges
- Sand bedded cubicles can add to grip on flooring, but can also increase wear of concrete and soles
- A grooved finish can be provided on new concrete, generally a hexagonal finish which should be 46mm sides and 10mm deep, with a minimum of 6mm deep

Table 3 Hexagonal Grooving on Concrete



In Holland, the hexagonal pattern is created by tamping a pre-formed rubber template into the floor and removing the template as the concrete cures.

If improving existing concrete, diamond cutters are preferred to flail cutters to avoid aggregate becoming exposed and risking damage to cows feet. Where dairy cows are housed in cubicles using sand bedding, there are reports that the sand provides initial improvement in grip on the passage floors. However, over time, as happens in the US, sand will polish the floor surface, which can lead to a slippery surface unless some grooving is carried out.

Grooving worn concrete has a cost benefit, mainly in savings from a reduction in lameness. The major problem in USA was excessive wear on feet, and some of this would be as a result of sand bedding and walking on abrasive concrete.

In the EU research LAMECOW project, different flooring types were investigated, the key findings were:

- Cow tracks were improved with rubber chippings
- Cows prefer rubber compared to concrete and solid compared to slatted floors to stand or walk on

Although claw wear is less on rubber flooring, it is still comparable to claw wear on old, worn concrete, however, claw growth is also slower on rubber. This is in evidence on many of the farms I visited in America, where rubber is used in targeted areas, such as high traffic areas to and from the parlour/ collecting yards. It seems that lame cows, however, are sometimes not keen to walk on the rubber areas, especially if they are areas of high traffic, where they may be knocked by a dominant cow. The solution may be to keep extremely lame cows in a straw yard or separate holding area, to prevent these interactions.

Picture 1: Wisconsin dairy unit using rubber mats on high traffic areas

Handling Dairy Cows

There is increasing evidence of the importance of behavioural environmental interaction, especially with a hard unforgiving surface such as concrete, and its effect on the animal.

Cow Tracks

There are a number of track recommendations, mainly in the UK and NZ as cows are moved to pasture. The sourcing of stone or rubble for a new track, is dependent on area and costs vary greatly as per table x below.

The best tracks I have seen working are the concrete sleepers, they are easy to maintain and manage, and can be moved around the farm and from farm to farm if necessary. The biggest problem with them, and any solid track such as concrete, would be stones and mud, these should be maintained with a mechanical brush, to prevent trauma to the foot.

Table 4: Cost Per Running Metre of Common Cow Tracks

Type track	Width (m)	£/m²	£/running metre
Repair existing stone track	**3**	**2.00**	**6.00**
New track with rubble	**3**	**4.80**	**14.40**
Concrete sleepers	**2.4**	**12.22**	**29.33**
New concrete track- 4 inch deep	**3**	**17.13**	**51.40**
Cow & tractor track			
Repair stone track + cement	**3**	**9.50**	**28.50**
New track with rubble & cement	**3**	**12.30**	**36.90**
New concrete 6 in deep	**3**	**20.78**	**62.35**

Table x from Farmers Weekly 9th October 2009 (Kingshay data)

A poorly maintained track can cause disruption to the flow of a herd, and the most common problem areas for cow tracks are:

- Lack of maintenance. A good cow track can quickly become a poor one if it is not maintained, and repaired where necessary.
- Lack of adequate drainage. A good cow track will have greater longevity and use if it is well drained at the start, this can be achieved by using rubble as the base layer, and ensuring a camber on the surface.
- The point at where it meets a junction, particularly with concrete
- Sharp bends and narrowing of the track

The design of tracks determines the voluntary walking speed of the herd, where cows have a well drained, non abrasive surface to walk on that is wide enough for the herd. Cows should be allowed to walk at their own pace, with their heads up, so they can see where they are placing their feet.

Cow Comfort and Cow Flow

All of these are vital elements in achieving good cow flow, and in lameness management.

Cow Comfort

Poorly designed and managed facilities cause injuries and increase the risk of health problems such as lameness, producers spend millions of pounds building and renovating their systems with the aim of providing a comfortable environment for their dairy cows, but there has been little work done to assess cow comfort on commercial farms and to allow producers to evaluate their own facilities.

Irrespective of the housing system chosen, the facility must provide a comfortable place for the cow to lie in. Measurement of cow comfort is subjective, and therefore a recognised method of assessing cow comfort is to record lying times or some of the other measurements detailed further in this section.

In Canada Nina von Keyserlingk, Dan Weary and their team, have many key findings on cow comfort, from their research at the University of British Columbia (UBC) in Canada. When I visited them there were a number of key findings and recommendations in this area:

- There are a number of ways to assess cow comfort, but it can be accurately measured by using data loggers to monitor stall design and its effects on cow behaviour. These results are being implemented in Canada in designs of new dairy cow housing.

- Cows prefer softer lying surfaces with more bedding, and spend more time lying down in well bedded dry cubicles.
- The configuration of cow cubicles (dimensions, position of neck rail etc) can have a major effect on cow comfort, and on standing behaviour.
- Cows may seek refuge from hard concrete floors, by standing in the cubicle. If we want cows to lie down for more than 12 hours then we need to address this in the planning of cow housing, and make sure that the remaining 12 hours they spend on their feet are on as comfortable surfaces as possible.
- Cows standing on wet concrete can absorb water through their claws, causing them to become soft and increasing risk of wear (Borderas, 2004) and solar lesions (Chapinal *et al*, 2009). The benefits of keeping cows feet as dry as possible are innumerable; cows are more at risk of picking up infections in yards with deep water and slurry, and with water absorption predisposed to other problems.
- Layout of the cow building can affect cow comfort; in particular cubicles closest to the feed passage are often more used, as are those in the centre of a row. Cows don't want to walk far to eat, and also want to avoid obstacles such as walls and narrow passages, and in some cases to avoid confrontation with a dominant cow.

Table 5: US Targets for Cow Comfort

Targets for cow comfort	
Time budgets	> 12 hours resting time
Cow comfort index	> 85%, 1-2 hours post milking
Stall standing index	< 20%, 2 hours premilking
Rumination time	> 50% of resting cows
Lameness scores	> 70% completely normal
Hock scores	> 95% without any swelling or hair missing
Floors	Confident traction without hoof wear
Heat stress	Respiratory rates < 70 bpm, rectal temp. < 102 degrees
Fly control	No bunching during the summer

Poor cow comfort is often an indirect cause of claw horn related lesions. There are a number of comfort measurements, to provide a more precise way of defining what cows are doing in relation to their housing environment, that has a direct relevance to lameness.

Cow Comfort Index (CCI) is the number of cows lying in a cubicle divided by the number of cows touching a cubicle surface. This gives a numerical expression for the proportion of cows in cubicles that are actually lying down. The target should be 85% or more of cows lying 2 hours post milking

Proportion Eligible Lying (PEL) is the number of cows lying in cubicles divided by the number of cows in the pen not eating. This shows us how many of the cows in the pen that are eligible to lie down in the cubicles (i.e. they are not eating) are doing so, the figure to target should be more than 75% of cows should be lying in a cubicle one hour after returning from milking

Stall Standing Index (SSI) is the number of cows standing with two or four feet in a cubicle, divided by the number of cows touching a cubicle surface. It is the inverse of CCI, and shows the proportion of cows in cubicles that are standing, therefore two hours before morning milking target figures of 15% or less would be desirable.

These are not very user friendly terms, but do put a measure on cow comfort, perhaps the easiest way to measure these would be PEL describes cubicle acceptance, and CCI describes actual cow comfort. These measures do allow an accurate evaluation of cow comfort, truly reflecting what the cows think of the cubicles, I think CCI would be a quick and easy measure for UK farmers to adopt.

Cow Flow

There has been a large amount of work done in recent years in New Zealand and America on cow behaviour and cow flow. I think it is a big area, that isn't considered in the UK, but most of the recommendations are often common sense, and offer a low cost and simple solution to some of the problems occurring on modern dairy units.

I met Neil Chesterton from New Zealand, several times during my travels, and each time he inspired me to think about cow flow differently, not just on cow tracks, but in collecting yards, in and out of the milking parlour, and how we as humans can affect cow flow. The two key messages I repeatedly picked up were that the two main factors affecting cow flow are the stockman himself and the facilities that person is using.

Temple Grandin from the States also revolutionised cattle handling, by relating back to the basics of animal behaviour. These are explained in depth in her book Animals in Translation (ISBN 0-7475-6668-2).

Collecting yard and milking parlour management

Tightly packed cows, skidding on concrete can cause foot damage and stress on the white line junction. I understand this work was developed because of the large number of cows handled in NZ, and the long distances they are walked to and from pasture. I heard Neil Chesterton talk about this many times, and I am a convert to the whole idea and rewards of good cow handling.

- Ensure enough space in collecting yard minimum of 1.5 m^2 per cow for larger cows (1.3 m^2 for Jerseys) all cows should have their heads down, if they are up it means they are too tightly packed (either in yard or on a cow track). If a cow jerks its head up, it means she has trodden on something painful. When handling cattle, all of their head should be down all of the time.
- Non slip surface
- Slope should be less than
- No sharp bends
- If using a top gate, ensure it is not running too fast. It should not be more than 12 metres/ minute for a rotary and 6 metres/ minute in a rectangular yard.
- Do not move the backing gate until at two rows are milked (every 15 minutes minimum) and in 5 second bursts.
- Install a bell so cows instantly know when the gate is moving, and move instinctively. No sharp turns out of the parlour
- No sharp edges or pipe ways that will cause pin bone injury.

Because cows are creatures of habit, they will get used to the predictable handling and movement of the gate. As a result foot damage will be minimised and lameness reduced.

Human Behaviour

- Cows respond to voices, and are afraid of low, sharp and harsh voices, so a friendly tone should be used.
- Train staff to carry out the same timings and routines, each time they handle cows. A cow is an amazingly co-operative creature of habit if trained correctly as well.
- New staff should be taught the commands and the correct tone of voice.

Stray Voltage

I believe this deserves a mention, because stray voltage causes discomfort and impedes normal behaviour, and if the animal is reacting under pressure can put unnecessary pressure on the sole of the foot.

Stray voltage is the flow of alternating current on the grounding conductors of a wiring system, and a cow will get a shock from the voltage (alternating current) difference between different surfaces, such as pipe work, concrete floors and water. Cows will react to low voltage of 0.05 to 0.07 volts.

Symptoms of voltage problems are hard to define, but may include slow or incomplete let down, mucking in parlour, poor cow flow in and out of the parlour and a reluctance to pack together in the milking bale.

The only solutions are to ensure wiring and equipment are installed correctly, and make sure that all points touching the cow are bonded together, so there are no voltage differences.

Nutrition

My report did not set out to examine the influence on diets and feeding on lameness, however, it does have an impact and therefore needs an overview as part of the report. The key issues to tackle are:

- Laminitis
- Acidosis
- Forage/ fibre ratio
- Protein
- Minerals and vitamins

Certain types of lameness are caused or aggravated by the cows' nutrition, often due to the influence on the corium of the hoof (nail bed). The corium is an area of soft tissue containing nerves and blood vessels, providing oxygen, amino acids, minerals and other nutrients to sustain horn growth. Horn is formed when living epidermal cells move slowly towards the outside of the foot, accumulating a hard protein structure called keratin.

Laminitis, or inflammation of the corium, can occur sub clinically and cause minor changes to the corium, but these changes can affect horn production for the rest of the cow's life.

Most cases of lameness appear 8 weeks after calving, with peak foot lesions occurring 16-24 weeks into lactation, as horn growth takes 6-8 weeks, this suggests feeding at calving and early lactation have a significant role.

Acidosis is a lowering of rumen pH, caused by too much acid resulting from overfeeding of concentrates (starchy feeds). The increased acidity of the rumen kills some of the rumen microbes, producing toxins and then histamines, which are released into the bloodstream. The damage caused to the blood vessels, restricts blood flow to the hoof and can cause poor horn growth and quality.

Forage and fibre are key to a ruminant diet and a shortfall in adequate forage can allow acidosis to develop, by providing sufficient fibre to maintain rumination could be significant in minimising laminitis. Acidic rumens and inadequate intakes of forage can also be caused by:

- Very wet, acidic silages causing restricted intakes
- Silages high in ammonia and poorly fermented are likely to reduce intakes
- Very leafy (high D-value) silages contain less fibre and therefore need higher intakes
- Chop length also has an impact on intakes, and rations should contain a mix of short and long chop

Protein

Minerals, vitamins and Trace Elements

At the Cattle Lameness Conference in 2009, Laura Green found that biotin fed cattle have improved horn cell adhesion. It has been proven in many studies to improve hoof horn density, and recommended feeding rates are 10-20 mg/ day. In the States, diet is seen to be of the highest ranking in lameness prevention, but personally I think other areas discussed in depth within this report have higher implications.

For a nutritional check list to minimise lameness see appendix 1.

Genetics

Swedish foot trimmers are trained to record claw lesions during routine foot trimming sessions, and these records are used to generate breeding values for claw health. Each farmer and claw trimmer can receive their data with statistics from the web and compare to national means. Selecting bulls giving progeny with healthy feet is a long term measure for good mobility and top performance, and since they are recording over 200,000 trimmed cows annually, the information is reliable.

It does appear that like mastitis, lameness is negatively associated with yield, also standard conformation parameters of sires currently used in type classification do not appear to offer good relationships with lameness, yet these are still being used.

Youngstock management

Management of the heifer is of prime importance. Studies show that claw lesions can be evident in young growing heifers less than 12 months of age, and

that heifers exhibiting these lesions are 28 times more likely to become lame in their first lactation.

Assessing Risk Factors and Prevention

- Assessing Risk Factors
- Prevention
    - Foot bathing
        - Hygiene Scoring Card
    - Foot trimming
    - Early Detection and Treatment
        - Benefits of Early Detection
        - Zinpro FirstStep
        - Dairy Co Mobility Score
        - Records....and their use

Assessing Risk Factors

There are different levels of attacking lameness on a farm- either in response to an acute situation or as part of a long term strategy, by identifying risk factors and then eliminating/ reducing these risks. Often both situations are evident at the same time, and actions can be taken in both the short and longer term.

Prevention

In 2007 David Logue and Christer Bergsten presented a paper entitle “lameness in dairy cows- a welfare and profit reducing problem”, which recommended the industry adopt a simple 5 point plan based on their research:

1. Identify, treat and record all lame cases immediately, using these records to target the most appropriate risk factors
2. Ensure good claw shape and health by regular foot trimming and recording of lesions
3. Reduce environmental challenge to the foot by attention to detail
4. Ensure well balanced food with adequate access for every cow (including water)
5. Select for sires whose daughters have a proven record of good foot health

I think this is a good summary and a good starting point for the industry to take a plan like this forward. Before the mastitis 5 point plan was introduced in the 1960’s there were an average of 150 cases of mastitis per cow per year in the UK with average cell counts of 600,000. By 2001 this had fallen to 60 cases of mastitis per cow per year, with an average cell count of 150,000. This shows that as an industry, we can solve problems, but we need the right tools and information to facilitate this.

Foot bathing

Design and siting recommendations for footbaths should include the following:

- Should be sited in a well lit and ventilated area
- Adequate length, width and depth
- Quick to fill and empty
- Should not disrupt cow flow
- Smooth but non slip floor

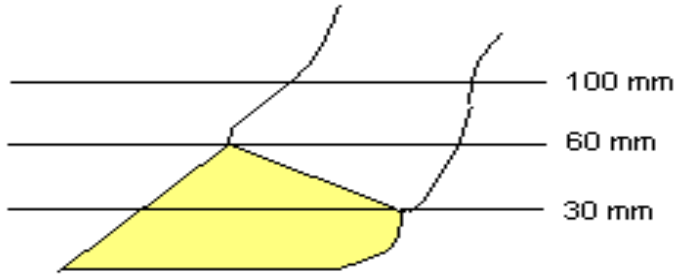
I asked myself the following questions, how effective are current treatments, what should we be using and how often should we be foot bathing? Foot baths are more effective the longer a cow stands in it, for example copper sulphate is more effective when used for 6 seconds exposure time rather than 3 seconds. It is also more effective at 10% concentration than at 3%. Parlour washings are readily available and a cheap disinfectant, but their effectiveness is unknown. In the States they were using formalin at up to 10% concentration, UK figures recommend 3-5%, there's no point wasting disinfectant on unnecessarily high concentrations. Formalin is highly corrosive and this was evident with erosion of concrete footbaths in USA, it should be handled with extreme care.

Research on foot bathing suggested the following best practice:

- Copper sulphate is effective over a wide range of cow passes
- Do not store formalin footbath solutions and do not use at a concentration of greater than 5%
- Addition of straw does not affect the efficacy of formalin, but may affect other disinfectants by way of dilution
- Milk plant washings are as effective as other foot bathing solutions, but need an immersion time of more than 4 seconds for full exposure therefore ideally a 4m long bath.
- Foot bath length is critical and cows need at least 4 steps in the bath (2 steps equals less than 3 seconds immersion). Pre wash bath should ideally be 3 metres with the treatment bath being 4 m.

For any disinfectant solution to be effective it must first come into contact with the organisms it is intended to kill.

Table 6: Approximate representations of different depths of footbath solution

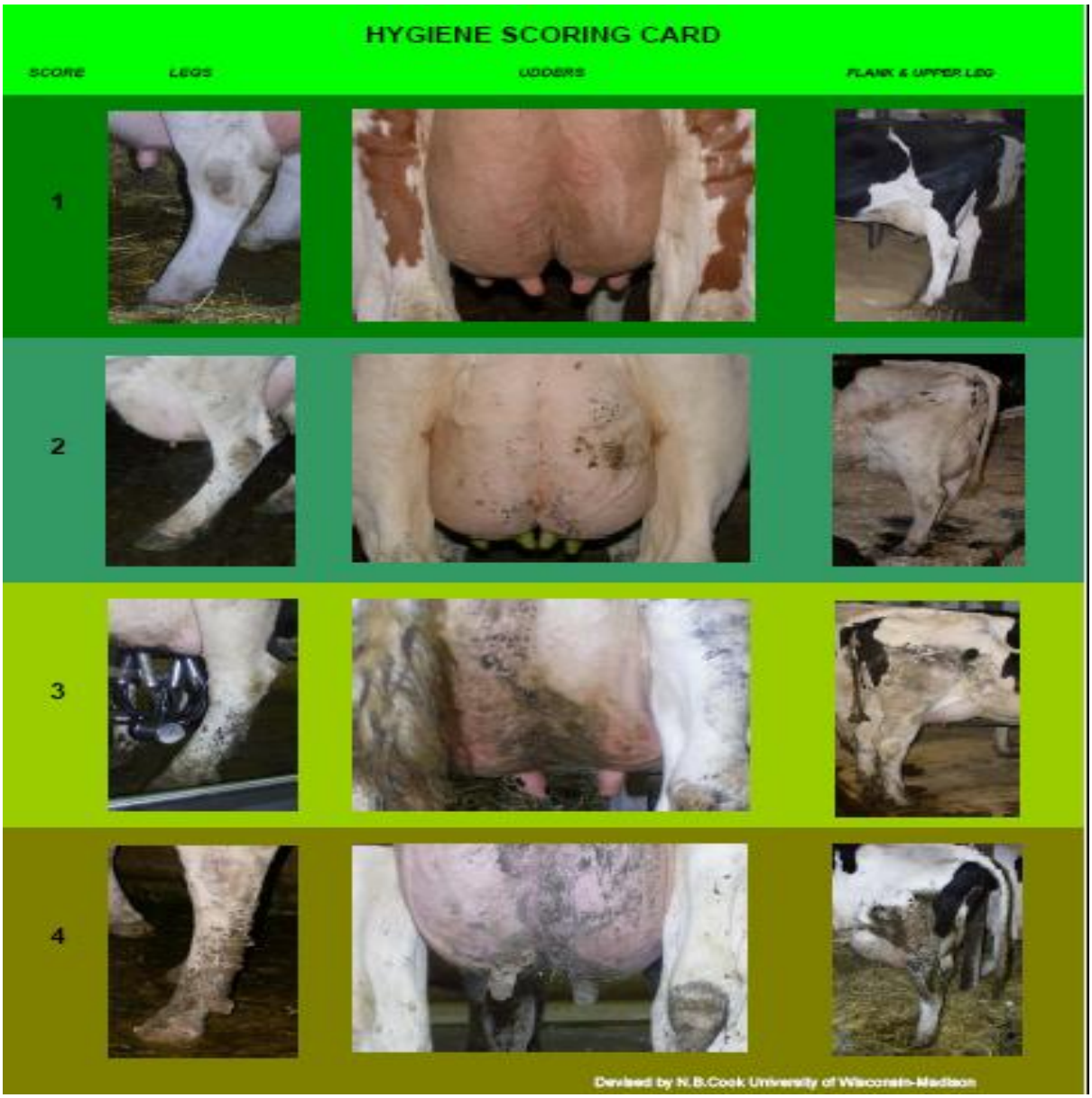


Optimum level of depth 8cm, preferably 10cm for treatment and pre wash. It is worth noting that heels on the hind feet are lower than the front and therefore more prone to DD.

Appendix 6 details the amount of concentrated chemical required for a footbath and appendix 7 footbath capacities with a solution depth of 100mm.

There are a number of automatic foot bathing systems some auto fill and empty, some with spray jets. Based on cost benefit, these seem better suited to large herds where the footbath needs to be cleaned frequently. I saw a 900 cow unit where this was working successfully emptying and filling every 150 cows.

Table 7: Hygiene Scoring Card



The scoring card was developed by Dr Nigel Cook, who I spent a lot of time with in Wisconsin; this was used as an aid to assist in frequency of foot bathing decisions. The score is one to four, with one being clean hocks and udder, and score four being dirty hock and udder, with scaling of manure evident. The score suggests that the dirtier the cows are the worse the foot hygiene is on the farm, and therefore there is a greater need to foot bath more frequently. Targets are:

- Less than 25% of herd score three and four, suggests the herd can be foot bathes when required
- More than 85% score three and four, suggests that cows need to be foot bathed daily

Foot Trimming

The first acute preventative measure is regular foot trimming, primarily to treat new disease in lame cows and to detect and treat other lesions before a healthy animal becomes lame. Swedish research shows that foot trimming routinely twice a year, reduced lameness and solar ulcers by 40% compared to trimming once a year.

Hoof growth is relatively slow at 5mm per month; shape of the hoof is a product of growth versus the rate of wear.

- Aim to trim cows twice a year minimum
- Once a year at dry off and mid lactation

However, by the time an animal is showing a sign of lameness, foot trimming is unlikely to prevent economic losses being incurred, and the animal's welfare being impaired.

XL vets are running lots of regional courses on practical foot trimming to get farmers and their staff trained, and there are many qualified, highly skilled operatives on the national Association of Cattle Foot Trimmers website. There are no excuses for farmers and their staff not to attain basic qualifications and knowledge in foot trimming, and the Swedish 5 step plan provides a clear, structured and proven method for hoof trimming.

In USA the common practice for a lot of the preventative measure for lameness, was to train staff to do specific roles, so it that role was their responsibility. It seemed a common practice for the person that moved stock to and from the parlour carried a clip board recording lame cows, and with foot trimming it was one person's responsibility to trim feet, and to support training for other staff members if required. This was part of their health plan, including that if that person left, someone else would be trained to fulfil that role.

Foot trimming training and accreditation across the globe seems fragmented, and I think we have an excellent pool of professionals with the NACFT. This association provides training and support, an annual conference and recognition of the diploma skills that can be attained. In the US foot trimmer accreditation varies enormously, in Florida there is the Master Hoof Care Programme, whose objective it is to train technicians in foot care and claw trimming, with a similar scheme in Wisconsin. In essence accreditation is not a requirement to be able to trim hooves; anyone can carry out this task. I would recommend that anyone picking up cows feet regularly for routine inspection or trimming, at the minimum has some form of training to see the impact this has on the claw shape and weight bearing.

Early detection and Treatment

Researcher David Tisdall at Bristol University, found the following preliminary results in year one of a three year trial, which backs up the financial, welfare and cattle health value of the early detection of lameness. This is the first trial work, which backs up the benefits of picking up lame cows at the stage where they have uneven gait, and treating them. The trial involved mobility scoring every fortnight and identifying score 2 cows on a mobility score, half were treated immediately and the other half left for conventional treatment, i.e. these were treated when they were normally seen to be lame. Early intervention prevented more severe lameness problems from developing and resulted in 74% of these cows recovering in 2 weeks. Only 50% of "conventionally" treated cows recovered within 2 weeks.

It would appear from these early results that 50% of cattle are lame 100-200 days before being identified for treatment by conventional methods; however the screened/ early detected cows were lame 0-14 days before treatment with a 74% recovery rate.

The benefits of fortnightly scoring and early intervention were improved animal welfare, reduced pain and a faster return to "normal" leading to increased performance, better fertility and longer lifespan.

Zinpro Stepmetrix costing in the region of £25,000 consists of force plates on a platform, normally fixed in the return lane from the parlour. The plates analyse the force and duration of the cows' steps from the hind claws, producing a numeric value, transmitting the results to a linked PC. These scores can be used to identify and track lameness on individual cows, groups of cows or the whole herd, a score over 38 on this system suggests the cow is experiencing pain from lameness. Appendix 7 details the system.

The programme only analyses the rear claws for lameness, and if visually scoring you would analyse all four feet. The cost would also be prohibitive on most commercial units.

Dairy Co mobility score was launched in 2009, and was developed because of the lack of uniformity of scoring systems across the UK, where there were potentially 8 different scores available. In conjunction with industry representatives I organised a meeting at Nottingham, where 50 delegates discussed scoring lameness, descriptors and nomenclature, and the result was the mobility score comprising of zero to three.

Since beginning my scholarship I have seen mobility scoring used a lot, particularly in USA and in the UK, more commonly as part of a milk contract. Farmers using the system regularly, find they have a better handle on the problem cows, and can see improvement through the figures showing increased

cow numbers scoring 0 and 1. Many companies are offering mobility scoring services, where farmers pay a fee for a third party round to visit their farm and score monthly.

Table 8: DairyCo Mobility Score

DairyCo Mobility Score

Category of score	Score	Description of cow behaviour	Suggested action
Good mobility 	0	Walks with even weight bearing and rhythm on all four feet, with a flat back. Long, fluid strides possible.	• No action needed. • Routine (preventative) foot trimming when/if required. • Record mobility at next scoring session.
Imperfect mobility 	1	Steps uneven (rhythm or weight bearing) or strides shortened; affected limb or limbs not immediately identifiable.	• Could benefit from routine (preventative) foot trimming when/if required. • Further observation recommended.
Impaired mobility 	2	Uneven weight bearing on a limb that is immediately identifiable and/or obviously shortened strides (usually with an arch to the centre of the back).	• Lame and likely to benefit from treatment. • Foot should be lifted to establish the cause of lameness before treatment. • Should be attended to as soon as practically possible.
Severely impaired mobility 	3	Unable to walk as fast as a brisk human pace (cannot keep up with the healthy herd) and signs of score 2.	• Very lame. • Cow will benefit from treatment. • Cow requires urgent attention, nursing and further professional advice. • Cow should not be made to walk far and kept on a straw yard or of grass. • In the most severe cases, culling may be the only possible solution.

In general:

- Cows should be scored once a month and the information recorded
- Ideally on a hard, on slip surface, watching the cow from side and the rear if possible
- Record the identities of cows scoring 2 and 3 and schedule treatment
- Keep a tally of cows scoring 0 and 1
- If you are uncertain about the exact score of a cow, make a repeat observation and if still unsure, examine her feet.

Key benefits of scoring:

- Every cow is regularly assessed for the early sign of poor mobility
- Trends can be monitored to identify new problems at an earlier stage

- Provision of figures for benchmarking performance
- General foot health awareness is increased
- Motivates farm staff to improve herd health mobility and therefore overall herd health

Records...and their use

If you can't measure it you can't manage it

You need to know what the main hoof problems are on your farm and the scale of the problem, before you can treat, control and hopefully prevent some of the issues causing the problems. Without detailed records of each cow trimmed you have no chance of addressing what is happening now, finding any patterns of key issues and preventing them from happening. Regular mobility scoring is an essential step towards early identification of cows, assessing the herd status and monitoring any improvement.

Keen to support farmers in the utilisation of foot trimming records, which can be a gold mine of management information, DairyCo are looking to work with the Category one trimmer's within NACFT, in the first instance to pull together a database of incidence of foot lesions. To aid in the gathering of the data, DairyCo are working on producing triplicate recording sheet pads (appendix 8) and a central resource to do the data correlation. This development will aid with monitoring the improvements being made in foot health in the national herd.

Lameness records can be tracked on paper in a simple excel spreadsheet or on computer programmes such as interherd. There are also downloadable systems from USA. In Sweden, Christer Bergsten detailed their recording system, which is used by professional foot trimmers, record individual cow data from trimming, and then this is used by the national database for bull selection. A poster that I saw at the lameness conference in Finland by Konig and Landman from Germany concluded that genetic progress towards foot health can be tripled by using foot disease records for selection.

Lameness prevention programmes

Healthy Hoof Programme- New Zealand

Funded by MAF and DairyNZ, and developed by Neil Chesterton (a New Zealand vet), the Healthy Hoof Programme is a practical and systematic approach, aimed at reducing the incidence of physical lameness on farm. The programme focuses on lameness prevention, in conjunction with information and training on management and treatment of lame cows.

Farmers sign up to the programme with their local vet, who will have been trained on the system. The vet then visits the farm, and carries out an assessment of the farm and management systems. The vet then delivers training in prevention, but more importantly in my opinion delivers an action plan, based on the management of the herd, highlighting all the factors likely to be causing lameness, with solutions. Finally, there is a monitoring visit after 6 months, and at the end of the year on the programme.

Farms also receive a Healthy Hoof toolkit, which includes a field guide to help with diagnosis and treatment of lame cows, wall posters, recording templates and information on treatment and prevention for farmers and staff.

This has to be the key, in this type of programme, a guide on reviewing your management practices and then a list of recommendations based on individuals systems, with a list of remedial actions that can be put into place. My recommendation is that this type of programme is developed in the UK.

FirstStep- Zinpro

FirstStep is a programme developed by Dr Nigel Cook and his team, with Zinpro. It is a commercial programme targeted for use by advisors and nutritionists to an interactive tool for investigating herd lameness. A tutorial package provides background information and training on a range of lameness related topics. The programme also contains a database, which is used to store and summarize data collected from a farm, in a series of reports that can be used to develop a herd specific action plan.
I saw this being used very successfully on farms in Wisconsin, the collection of data to appraise the system took the team about a day, plus the report writing and return visit to the farm. Kite currently have the UK licence to use this programme in the UK.

Technology Transfer

I like the work that Becky Whay at Bristol has done on social marketing, because it looks at different ways of facilitation and how to change behaviours, Becky suggests that key points that encourage change are:

- Seeing that the benefits outweigh the barriers
- Knowing that others have been able to succeed
- Feeling ownership of their own decisions to act

Conclusions

Lameness will continue to be a problem in the industry, unless we start to examine ways to review systems and identify a few key areas, where improvements can be made. There will always be pressure on businesses, where labour and time are a key issue, but developing support tools and using extension to support delivery should assist in this area.

Lameness in dairy cows is one of the most common reasons for early culling, and one of the most prevalent diseases on dairy farms. It is a complex and multi-factorial disease, and there is still a lot of work needs to be done to examine the role of the environment, yield, genetics and nutrition on the disruption on the structure of the foot.

The key areas that farmers should focus on are good cow comfort, dry feet (where possible), free flowing movements around the farm and pasture (cow flow), routine foot inspection and trimming, early identification and prompt treatment.

The design of the system and the level of management applied to the system, can affect the health of the cows. The cleanliness of the housing and animals can have an impact on both lameness and mastitis.

The development of an industry supported mobility score means that animals can be identified for early attention and treatment; it is more on the agenda/ radar than it has ever been, and this can only be a positive.

More UK farmers need to have a can do attitude to lameness, there are pressures both outside and within the industry to change attitudes and approaches to lameness, we just need the tools to support this further.

Recommendations

- Identify and treat lame cows earlier
- That anyone carrying out routine inspection and trimming of cows feet, have some form of basic knowledge of foot structure and trimming technique.
- There needs to be more information available to the industry on the impact of cow handling and how it affects cow behaviour and disease. Many of the ideas and solutions are simple and low cost.
- The industry needs to develop a programme that allows farmers to identify their weak areas in their systems causing lameness, to enable an action plan to be developed, with key priorities.
- In order for a business to carry out an investigation of the lameness problems in the herd, there need to be number of factors addressed:
    - Record the levels and types of lameness- this would be possible in the future with the NACFT duplicate recording sheets being left on farm and being made available
    - Draw up a simple investigating plan
    - Make recommendations based on the plan and make changes
    - Monitor the progress
- Cow comfort is key- the cows will tell you if the system does not suit them
- Producers should consider using rubber flooring for high traffic areas, and areas that need attention such as collecting yards. There is little economic data on the use of rubber flooring, and more work in this area would be beneficial to the industry.

Appendix 1: Nutritional Check List to Minimise Lameness

Appendix 2: Lameness risk factors in dairy herds

Risk Factor	Type	Reason
Nutritional	Acidosis	Toxins released affect hoof horn production
	Transition diet	Too abrupt a switch will predispose animals to acidosis
Physiological	Calving	Retained placenta increases histamine levels affecting blood supply to hoof
	Hormones	Hormone Relaxin released to ease calving affects connective lamina tissue in the hoof
Environment	Flooring	Cement floor in loose housing cause excessive wear to hooves altering weight distribution
	Stalls	Badly designed stalls increase cows standing time which exacerbates lameness problems
	Manure	Dirty wet flooring conditions increase the risk of infectious foot diseases
Behaviour	Social	Low ranking cows such as heifers are bullied by older cows leading to hoof trauma as they try to avoid confrontation
	Walking	Excessive walking on cement increases the severity of lameness disease
Genetics	Breed	Holsteins have shallower hoof angles and are more prone to joint conformation problems than other breeds such as Ayrshires and Brown Swiss
	Hoof hardness	There is a strong genetic component to hoof hardness which reduces the risk from erosion problems in freestall systems

Appendix 3: Relationship between chest girth, diagonal body length and weight

Cow body weight (kg)	Chest girth (m)	Diagonal body length (m)
375	1.68	1.36
425	1.75	1.41
475	1.81	1.46
525	1.87	1.50
575	1.93	1.54
625	1.98	1.58
675	2.04	1.62
725	2.09	1.65
775	2.14	1.68
825	2.18	1.72

(Source: Dairy Co Housing the 21st Century Cow)

Guidelines on cubicle length

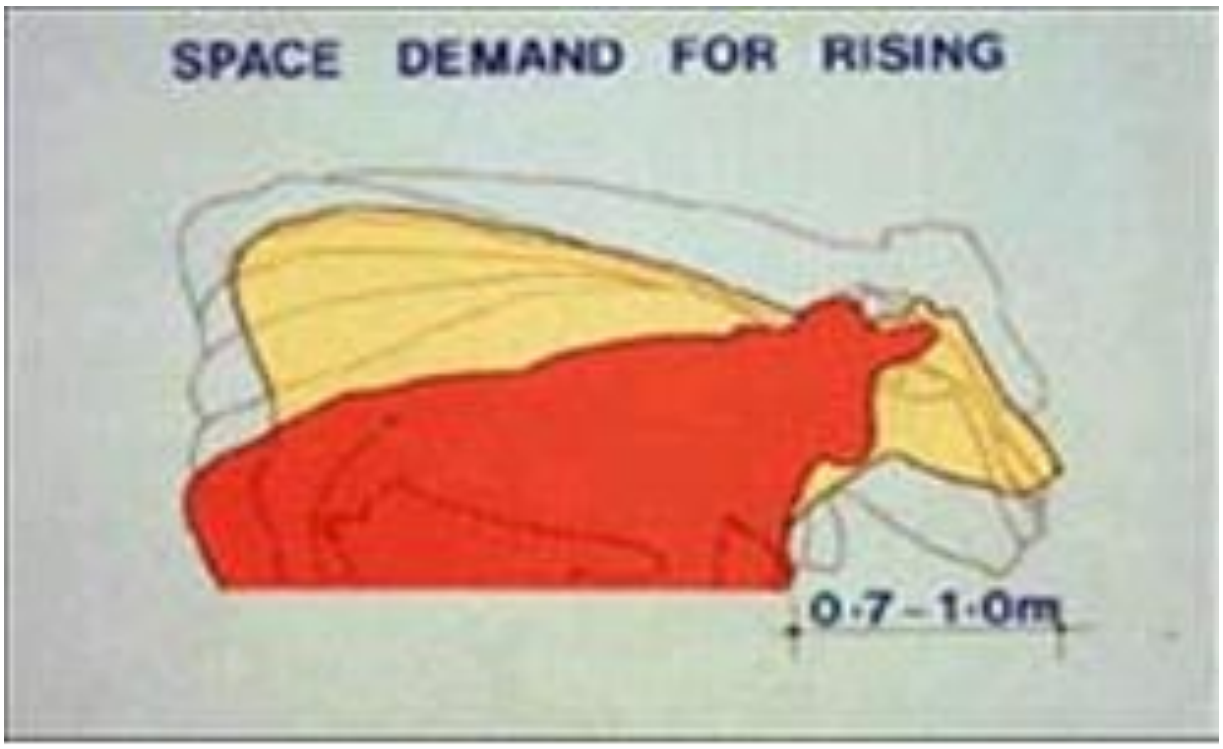
Weight of cow (kg)	Total length of bed (m) (open front)	Total length of bed (m) (closed front)
500	2.05	2.05
600	2.15	2.15
700	2.30	2.55
800	2.40	2.70

(Source: Dairy Co Housing the 21st Century Cow)

Minimum area allowances for dairy cattle in straw yards

Mass of animal (kg)	**Bedded area (m^2)**	**Loafing area (m^2)**	**Total area/ cow (m^2)**
200	3.5	2.5	6.0
300	4.5	2.5	7.0
400	5.5	2.5	8.0
500	6.0	2.5	8.5
600	6.5	2.5	9.0
700	7.0	3.0	10.0
800	8.0	3.0	11.0

Appendix 4 Space demand for rising



Appendix 5: Some on farm strategies for limiting lameness in dairy cattle

Strategy	**Action**	**Comments**	**Relative cost**
Reduce infection	Immediate treatment of all conditions with targeted treatment topical/ footbath	Record types of lameness and all treatments	Low
	Have lameness as priority in the health plan	Review annually and plan ahead- involve vet and foot trimmer	Medium
Ensure good claw shape and condition	Regular foot trim	Trained personnel	Low
	Regular routine preventative footbath	Wash feet first to keep footbath clean	Low
	Prevent lesions	Apply all above and below	
Animal Factors	Training to system	Train heifers to cubicles etc	Low
	Genetics	Record keeping	Low
Reduce environmental impact	Lying comfort	Adequate bedding/ comfortable (mattress?)	Medium
		Good cubicle design	High
	Feeding space	Adequate space per cow (including water)	High
	Walking surfaces	Soft and non slip floors	
		Adopt best practice	High
	Good slurry system	Clean and dry flooring	High
Nutrition	Marry inputs to outputs (monitor by limiting body condition and weight loss in early lactation)	Limit weight loss post calving esp in heifers	Low
	Seek high palatability forages	Used mixed forages and aim for high DM	Low
		Limit concentrate meals and align with forage intake	Low
	Avoid macro or micro element deficiencies	If there is evidence of need use specific minerals to balance requirement	Medium

Source: D. Logue, C. Bergsten (2007)

Appendix 6: Calculating the amount of concentrated chemical (kg or litres) required for a footbath

Total solution in footbath [litres]	Required concentration rate					
	2%	4%	5%	6%	8%	10%
200	4	8	10	12	16	20
250	5	10	12.5	15	20	25
300	6	12	15	18	24	30
350	7	14	17.5	21	28	35
400	8	16	20	24	32	40
450	9	18	22.5	27	36	45
500	10	20	25	30	40	50
550	11	22	27.5	33	44	55
600	12	24	30	36	48	60
650	13	26	32.5	39	52	65
700	14	28	35	42	56	70
750	15	30	37.5	45	60	75

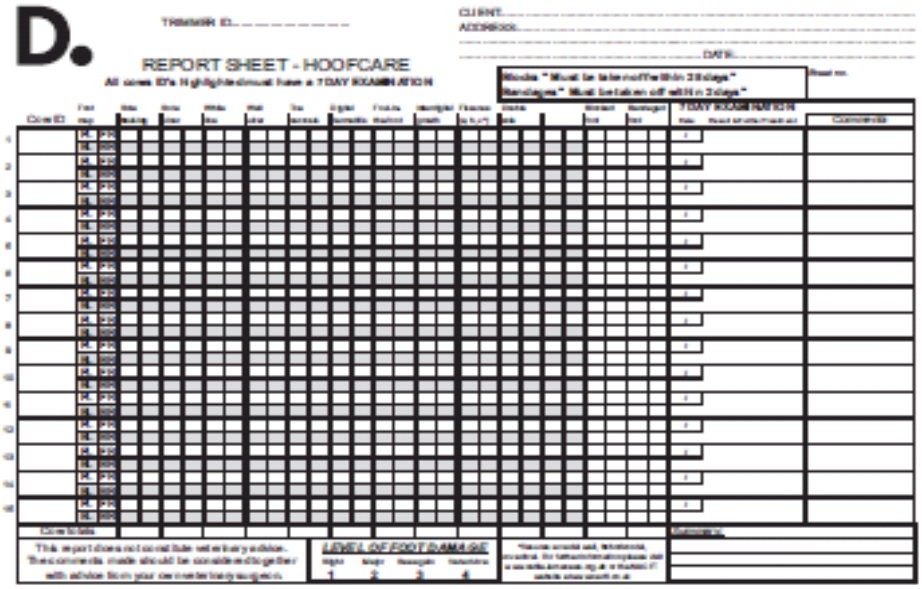
Source: Dairy Co Effective Footbathing of Dairy Cows

Appendix 7: Footbath capacities with a solution depth of 100mm

Footbath length metres	Footbath width metres	Volume of liquid litres
2.5	0.7	175
2.5	1.4	350
2.5	2.1	525
3	0.7	210
3	1.4	420
3	2.1	630
3.5	0.7	245
3.5	1.4	490
3.5	2.1	735
4	0.7	280
4	1.4	560
4	2.1	840
4.5	0.7	315
4.5	1.4	630
4.5	2.1	945

Source: Dairy Co Effective Foot bathing of Dairy Cows

Appendix 8: Lameness Report Sheet with 3 carbon copies



REPORT SHEET - HOOFCARE

DairyCo

Appendix 9: Zinpro Stepmetrix