

2016

# The Effect of a Health Intervention Scheme on the Mobility of Dairy Cows in the Southwest of England

Shepherd, Faye

<http://hdl.handle.net/10026.1/6564>

---

<http://dx.doi.org/10.24382/383>

University of Plymouth

---

*All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.*

*This copy of the thesis has been supplied on condition that anyone who consults it is understood to recognise that its copyright rests with its author and that no quotation from the thesis and no information derived from it may be published without the author's prior consent.*

**The Effect of a Health Intervention Scheme on the Mobility of  
Dairy Cows in the Southwest of England**

By

Faye Shepherd

A thesis submitted to the University of Plymouth in partial fulfilment for

**ResM Agriculture and Food**

2014

# **The Effect of a Health Intervention Scheme on the Mobility of Dairy Cows in the Southwest of England**

## **Abstract**

Health intervention schemes have previously been used in order to improve animal welfare and to reduce and sometimes eradicate disease (Bell et al., 2009). This investigation looks at the success of one such scheme upon the incidence of cattle lameness. Farmers participating in the Healthy Livestock Scheme, which took place in the South West of England from November 2010-January 2014, had their cattle mobility scored before commencing any mentored training, to determine pre-intervention lameness prevalence and again after intervention.

The results confirm there was a significant reduction in lameness, from an average 26.7% lame before any intervention to 20.4% after. This means there was on average, 23.6% fewer cases of lameness after farms had participated in the Healthy Livestock Scheme, than before. In an average 128 cow herd, this equates to seven fewer cows becoming lame each year and, based on a single case of lameness costing £180 (AHDB, 2016), this represents a significant saving of £1,283 per annum.

Importantly, none of the independent variables had a significant effect upon the change in lameness seen between pre and post-intervention mobility scores. This means the Healthy Livestock scheme was effective at reducing lameness regardless of farming system, breed, herd size, housing, or number of FTEs. The wider implications of this mean that, crucially, this type of funded vet and farmer interaction reaps benefits for all farm types, regardless of these factors.

## Contents

<b><u>Chapter One</u></b>	<b>Page Number</b>
Acknowledgments.....	6
Author's Declaration.....	6
<b><u>Chapter Two</u></b>	
Agriculture.....	9
Common Agricultural Policy.....	11
Single Payment Scheme.....	14
CAP Reform.....	14
UK Agriculture.....	15
The Dairy Industry.....	16
The Importance of the SW Region to the Agricultural Industry...17	
<b><u>Chapter Three</u></b>	
Cattle Lameness.....	19
Lameness Causes	
Animal Related Factors.....	20
Environmental Factors.....	23
Management Factors.....	26
Lameness Conditions.....	27
Prevalence.....	30
Lameness detection.....	31
Farm Assurance Schemes.....	35
Farmer Engagement.....	36
Health Intervention Schemes.....	38
<b><u>Chapter Four</u></b>	
Aims and Objectives.....	41
Hypotheses.....	41

**Chapter Five****Page Number**

Materials and Methods.....	42
Data Collection	
Sample Frame.....	44
Sample Size.....	45
Statistical Analysis.....	45

**Chapter Six**

## Results

Descriptive Statistics.....	47
Analytical Statistics.....	49

**Chapter Seven**

Discussion.....	52
Limitations.....	54
Research Recommendations.....	55
Industry Recommendations.....	55

**Chapter Eight**

Conclusion.....	57
-----------------	----

<b><u>References</u></b> .....	58
--------------------------------	----

**Appendices**

Appendix A.....	66
Appendix B.....	68
Appendix C.....	71

<b><u>Publications</u></b> .....	72
----------------------------------	----

## **Chapter One**

### **Acknowledgements**

The author gratefully acknowledges The Rural Business School, for granting access to the data collected through the Healthy Livestock Scheme and for allowing the use of work time in order for the author to complete the thesis. The author would also like to thank Paul Ward for the continued encouragement, help and support throughout the ResM and Dr Hayley Randle for her fantastic and unrivalled supervisory support, enthusiasm and feedback. The author would also like to express sincere thanks to friends and family, for continued encouragement throughout the duration of the Research Masters. Finally, the author would like to thank Combined Universities in Cornwall for granting a European Social Fund studentship in order to carry out the ResM.

### **Author's Declaration**

At no time during the registration for the Degree of Research Masters has the author been registered for any other University award without prior agreement of the Graduate Committee.

This study was financed with the aid of a studentship from the European Social Fund and carried out in Collaboration with Plymouth University in Partnership with Duchy College. During this programme of Post Graduate study, relevant scientific seminars and conferences were regularly attended at which work was often presented; external institutions were visited for consultation purposes and papers have been prepared for publication.

### **Publications**

**Shepherd, F., Ward, P. & Whitaker, T.** (2012). A preliminary study investigating factors affecting percentage of lameness in dairy cattle on farms in the south west of England. British Society of Animal Science, Healthy Food from Healthy Animals Conference, Nottingham, 24-25 April 2012.

**Shepherd, F., Whitaker, T. & Ward, P.** (2012) A Preliminary investigation into the presences, risk of entry and risk of on-farm spread of Johne's Disease within the South West Region of the UK. British Society of Animal Science, Healthy Food from Healthy Animals Conference, Nottingham, 24-25 April 2012.

**Shepherd, F. & Reigate, C.,** (2015) Farm Health Online- Cattle Lameness [ONLINE] Available at: [www.farmhealthonline.org](http://www.farmhealthonline.org)

**Shepherd, F., Ward, P. & Whitaker, T.** (2015) Johne's Disease in the south west of England. British Society of Animal Science, Annual conference, Chester, 14-15 April 2015.

### **Presentations and Conferences Attended**

**Presented:** A preliminary study investigating factors affecting percentage of lameness in dairy cattle on farms in the south west of England. British Society of Animal Science, Healthy Food from Healthy Animals Conference, Nottingham, 24-25 April 2012.

#### **BSAS President's Prize awarded for:**

A preliminary study investigating factors affecting percentage of lameness in dairy cattle on farms in the south west of England. British Society of Animal Science, Healthy Food from Healthy Animals Conference, Nottingham, 24-25 April 2012.



**Conferences Attended:**

International Conference on Lameness in Ruminants, Bristol Marriott City Centre Hotel, Bristol, UK, 2013

Cattle Lameness Conference, Sixways Stadium, Worcester, 2012

Cattle Lameness Conference, Nottingham University, 2011

CARS Symposium – Plymouth, December 2012

**Word count of: 15,845**

Signed: Faye Shepherd

Date: 28.04.16

## **Chapter Two**

### **Agriculture**

Agriculture and sustainable food production is key to the survival of the human race. World population (the total number of living humans on earth) has continued to rise since the end of the Great Famine (1315-17) and the Black Death (1346-53). Since then, the population has grown to the 7.2bn that it is today (November 2014), and continues to grow at a rate of 1.064%, which results in 145 net additions to the worldwide population every minute, or 2.4 every second (Central Intelligence Agency, 2014). Estimates project that the world population will continue to grow to 9.2bn by 2075, and that the majority of this growth will occur in developing countries (United Nations, 2004).

This increase in population size inevitably results in increased demands for food production. Indeed, it has been estimated that global food production needs to increase by between 50% by 2030 (Benn, 2009) and 70% by 2050 (DEFRA, 2009; FAO, 2009).

An increase in production is a challenge in itself, but it also needs to become more efficient and more sustainable, in a world where the amount of arable land is shrinking (Liu et al., 2010) and the climate is continually changing (Chen et al., 2014; Field et al., 2014). In 2012 the UK experienced the second wettest summer on record (Field et al., 2014; Met Office, 2013).

Following nearly seven years of new research on the global climate, the Intergovernmental Panel on Climate Change (IPCC) said that even if the world begins to moderate greenhouse gas emissions, global warming is likely to cross the critical threshold of 2 °C by the end of this century (Field et al., 2014).

A 2°C rise would have serious consequences, including sea level rises, heatwaves and changes to rainfall, meaning dry regions get less and already wet areas receiving even more. All of these potential scenarios have an impact upon crop yield which, as a consequence, could threaten food supply.

In the past, unstable food supply has resulted in some major catastrophes. The Great Famine of 1315, which was estimated to have reduced the world population from 450million to 350million (Kinealy, 1994) and the Irish Potato Famine of 1740-41 which resulted in over a million deaths (Ross, 2002), were both caused by starvation due to poor harvests. The Great Famine of 1315 began with unusually heavy and persistent rainfall throughout Europe, which caused universal crop failures. This coincided with a time in history when population levels in Europe were at a peak and demand for food was high. The sustained rainfall over a period of several years resulted in year upon year of failed crops. People utilised any food stores, and then began to starve once the stored had been depleted. The Great Famine had long lasting effects, and was not declared over until 1322. Even then, food stores only returned to normal levels in 1325. This highlights the importance of having food security high up on the global agenda.

More recently, the importance of food security was highlighted to the British government during the both the first and second world wars. At the time, 70% of Britain's food was imported (Harvey and Riley, 2009). Supply channels were under threat, which caused the government to spring into action. In response to the threat of loss of supply, the War Agricultural Executive Committee (WAEC) was set up in 1915, and backed by the British government to increase agricultural production in each county of the United Kingdom (UK).

The aim was to become more self-sufficient through increased production. In 1939, the British government gave the WAEC more powers and its immediate task was to see that *“additional land is brought under the plough with all speed”* (War Agricultural Committee, 1939). WAEC campaigns such as ‘Plough-up’ encouraged farmers to cultivate land for the use of food production. By 1944, 63% more land was being farmed in England and Wales than in 1939; cattle numbers rose to cater for the demand for dairy produce and mechanisation became an important part of farming (Elliott and Benson, 2012).

### **Common Agricultural Policy**

The Common Agricultural Policy (CAP) was launched in 1957, when the European Union (EU) identified a need to be sustainable and self-sufficient in its provision of food and *‘to make fresh advances towards the building of Europe’*. In order to achieve this, the Foreign Ministers of the European Community (France, Belgium, Italy, Luxembourg, the Netherlands and West Germany) agreed that there should be greater economic cooperation between their countries. This international agreement formed the basis of the creation of the Treaty of Rome, which established the European Economic Community (EEC). The aim of the Treaty of Rome was to create a common market of goods, workers, services and capital along with common transport and agricultural policies.

The introduction of the CAP ensured that farmers within EU member states received a minimum price for their produce and protected them from cheaper imports, with a long term view of improving food security.

The Treaty of Rome set out its basic principle and objectives:

- To increase productivity.
- To ensure a fair standard of living for the agricultural Community.
- To stabilise markets.
- To secure availability of supplies.
- To provide consumers with food at reasonable prices.

Implementation of the Common Agricultural Policy (CAP) began in 1962. The principal mechanisms for maintaining food production were through import tariffs and 'intervention', whereby food was purchased by the EEC when prices were low, and then stored to be eventually sold back when prices were higher, thus providing a more stable market place. By the 1980s, however, there was gross overproduction because the prices were set too high. The EEC was therefore buying excess produce in order to maintain prices, but this led to accumulations of excess produce, as market prices never rose to the levels set for selling back on to the market. Some of the surplus commodities were then sold, stored or disposed of at a high budgetary cost to the EU. Britain entered the EEC in 1973. Under the CAP, farmers continued to receive a minimum price for their outputs at a level above what they would (DEFRA, 2013) have received on an open market.

The food boom continued, surplus produce became known as 'food mountains' and concern from environmentalists grew over the more intensive farming systems, as the use of chemicals and large machinery in order to maximize outputs became commonplace. Smaller fields were being merged into larger fields, with removal of hedgerows in order to optimize arable land, which was deemed to threaten wildlife habitats. The EEC realised they had to take action in order to curb production and to safeguard the environment for the future.

To address this, in 1984, the EEC introduced milk quotas to slow the excess production of dairy produce. A milk quota is a limit on the amount of milk that a farmer can sell every year without paying a levy. If farms produced over their limit, they would incur a levy, which in the UK, is now collected by the Rural Payments Agency (RPA) on behalf of Defra.

By 1988, there had been considerable damage to agricultural ecosystems and wildlife habitat as a result of the intensification of agriculture. The EEC identified a need to further reduce the surpluses produced in Europe, whilst also delivering some environmental benefits. In 1988, the Set-aside scheme was introduced initially as a voluntary scheme that became compulsory in 1992 under the MacSharry reforms. Under the set-aside scheme, the EEC would compensate farmers, who withdrew land from production. This type of scheme paved the way for initiatives such as Cross Compliance (CC), which was introduced in 2003, as a mechanism for encouraging and rewarding farmers for achieving certain environmental and other targets, which then allows farmers to obtain governmental support, such as those from the CAP.

Despite agriculture contributing just 0.6% to the English economy (Farm Business Survey, 2014) CAP has, and still remains to be, a large part of the UK and EU's budget. Currently it is split into two pillars. The first, The European Agricultural Guarantee Fund (EAGF), primarily finances direct payments to farmers, such as the Single Farm Payment and accounts for 75% of the CAP budget. The Second pillar, known as The European Agricultural Fund for Rural Development (EAFRD), finances rural development and accounts for the remaining 25% of the CAP budget. The second pillar is where funding for initiatives, such as the Healthy Livestock Scheme, derive from.

### **Single Payment Scheme**

In 2003, the Single Payment Scheme, or Single Farm Payment (SFP), was introduced as a reform to the CAP and is currently the main agricultural subsidy scheme in the EU. The SFP was introduced as a subsidy for farmers which are calculated on a per-hectare of land basis. The intention was to create a stable market by moving away from direct payment for specific crops, which cause price distortion. The SFP is calculated based on the main EU currency, the euro. This means that the amount of SFP a farmer receives fluctuates along with the exchange, even though the area of land may remain the same. In England the Single Farm Payment was around 2.5% higher in 2013 than in 2012, which was due to a fall in the value of sterling against the euro (DEFRA, 2013).

In 2013/14, the SFP accounted for 50% of the national farm business income, with some sectors such as beef and sheep production particularly reliant on the SFP (Farm Business Survey, 2014). This demonstrates the reliance farming has on direct payments and subsidies. This is something the industry would like to move away from- instead, favouring increased efficiencies and better prices for produce.

### **CAP Reform**

At present, the CAP framework from 2014-2020 is under review and reform. Under the reform discussions, food security was high on the agenda, but quite how the CAP could contribute to both European and global food security is still to be defined (Candel et al., 2014).

In 2015, the SFP will be replaced with the Basic Payment Scheme (BPS). The BPS will work in a similar fashion, with details only just being released at the time of writing. Reform post-2013 will continue to include Cross Compliance (CC), despite recent doubts on the efficacy of the scheme (Meyer et al., 2014).

## **UK Agriculture**

The importance of agriculture to the UK economy cannot be underestimated. In 2013, the 'total income from farming' and 'gross value added' (GVA) from agriculture in the United Kingdom was £5.6bn and £9.2bn respectively (DEFRA, 2013).

The total number of cattle in the UK between December 2012 and December 2013 was 9.7million, which were spread across 222,000 holdings throughout the UK, (DEFRA, 2014). The UK's adult dairy herd remained static at 1.8 million cows for another year and the UK's beef herd continued to decrease, falling by 3.0% to under 1.6 million. The labour force consists of 464,000 people, which equates to 1.44% of national employment (DEFRA, 2013).

Recently (October 2014) the average price per litre of milk declined. This is worrying, as currently, a quarter of UK farms are already making a loss in Net Farm Income (net income taking into account the amount of attributed cost of rent and labour). The average annual farm business income in the UK for a dairy farm in 2012/2013 was £45,000.

Overall, the total output of livestock rose by £1.1 billion to £14.2 billion, a rise of 8.5%. The key contributor to this rise was the increase in value of milk, from £505 million to £4.3 billion. This was a result of the high prices seen throughout the year. The average price of milk in 2012 was 28.1 pence per litre (ppl)



compared to 31.6 ppl in 2013. The higher prices were due to increased demand from processors as the global demand for milk products rose in 2013.

With agricultural input costs rising 2.8% in 2013 compared to 2012 and livestock feedstuffs rising 8.5%, it is as important as ever to maximise profitability on farm in any way possible. Improving animal health by reducing disease, results in increased productivity and profitability, which is key for sustainable livestock production in the future.

### **Dairy Industry**

In 2013, there were 1.78m dairy cattle in the UK, making up 52% of the total adult cow population. The average milk yield per cow has increased year on year and has reached an all-time high of 7,535 litres per annum. Ten years previously, this was 13.8% less (6,621 litres per annum) (DEFRA, 2013). Similarly average herd size has increased from 102 to 128 over a similar period (AHDB Dairy, 2015).

The average milk price for 2013 was 31.6pp/l which was 13% higher than 2012. In 2013, the value of milk (31.6pp/l) and milk products rose by 13% to £4.3bn and despite a fall in the number of dairy cows in the UK, milk production increased by 0.7%.

The figures demonstrate the increasing demands on cattle, in order to be able to deliver the volume of milk required.

## **The Importance of South West Agriculture to the UK Industry**

Agriculture contributes 0.6% to the English economy, but is over twice as important to the South West economy and is the highest contributor of all regions with 1.25%. The South West of England (defined as the counties of Cornwall, Devon, Somerset, Gloucester, Wiltshire and Dorset), is predominantly a grass growing region and is therefore dominated by livestock production. Defra estimate that 24% of the national livestock output comes from the South West, with 39% of the English dairy herd, 35% of the beef herd and 23% of the national sheep flock (Farm Business Survey, 2014).

In 2012/13 the farm business income for dairy farms in the South West fell to £51,300 which was a decrease of 48% compared to the previous year (Farm Business Survey, 2014). This was due to the effects of severe weather. Cows were housed for longer periods than normal, thus increasing the quantity of feed required. The main source of income for South West farms was the Single Farm Payment, representing 70% of their total income. This is significantly more than the rest of the country, where SFP accounted for 50% of farm business income (Farm Business Survey, 2014).

This demonstrates that despite the significant value of South West farming to the economy, it is not as profitable as in other areas of the country. In order to improve the profitability of livestock production in the region, the Healthy Livestock Scheme, funded by the Rural Development Programme for England (RDPE), aimed to increase disease awareness amongst farmers, reduce disease incidence and in turn, improve efficiency and profitability.

## **Chapter Three**

### **Cattle Lameness**

Lameness is not a single disease but a symptom associated with a range of different conditions. (AHDB, 2016) define lameness in cattle as:

*“Any abnormality which causes a cow to change the way it walks, and can be caused by a range of foot and leg conditions, themselves caused by disease, management or environmental factors”.*

This abnormality in gait is normally attributed to the pain the individual experiences from the inflammation or infection of various areas of the claw. It is considered by many in the dairy industry to be the most significant welfare issue affecting cattle, and a condition that can be extremely painful (Whay et al., 1997).

Not only is lameness a welfare issue, but it is the third most economically damaging disease in dairy cattle (Enting et al., 1997), causing financial losses through treatment, as well as production losses due to decreased milk yield (Amory et al., 2008; Archer et al., 2010; Green et al., 2002; Reader et al., 2011), reduced fertility (Dobson et al., 2008; Hernandez et al., 2001, 2005) and increased culling (Booth et al., 2004). The average cost of lameness, including treatment, associated loss of yield and the potential for shortened productive life of the cow, is in the region of £180 per case (AHDB, 2016). At current levels of incidence, this could equate to a financial loss of nearly £15,000 for an average-sized herd, or well over 1p per litre of milk produced on the farm. This, coupled with the average duration of a clinical episode, 27days  $\pm$ 19 days (Whitaker et al., 1983), and of course, the significant associated welfare concerns, is why lameness reduction is now at the forefront of improving farm animal health.

## Lameness Causes

The causes of lameness are multi-factorial, but are generally broken down into three key areas; environmental, management and animal factors. These have been explored in a full review, see (Shepherd and Reigate, 2015).

### Animal Related Factors

Modern production related demands on dairy cows are thought to result in significant physiological strain on the animal. These demands often present themselves through clinical lameness. The primary physiological problem causing lameness is the shape of the pedal bone. The convex nature of the lower surface of the bone means the weight of the cow is not evenly spread across the bone (see Figure 1).

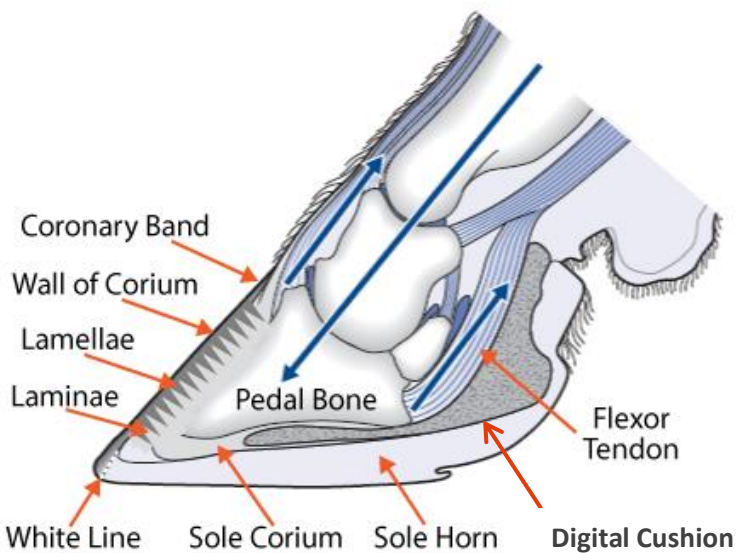


Figure 1. Hoof Anatomy. University of California, 2008.

Instead, there are concentrated pressure points on the lower edges of the pedal bone which can result in bruising of the corium and sole horn, particularly after prolonged periods of standing. If bruising is left untreated, it will manifest into sole ulcers, which are much more difficult to treat.

## **Body Weight**

In an investigation into weight, (Boettcher et al., 1998) found that heavier cows were more prone to lameness than cows of average weight. It was hypothesised that this was due to the increased weight and pressure being exerted on the claws, resulting in damage over time. However, in a more recent study by (Green et al., 2014), the Body Condition Score (BCS), milk yield and causes of lameness were recorded for a 600 cow herd over 44 months and analysed to investigate potential associations between the three. They found that cows with a BCS of less than 2 (therefore underweight), gave an increased risk of horn related claw lameness. They hypothesised that this was due to the thinner digital cushion in the hoof (see Figure 1). This is concurrent with findings in a similar, earlier study looking into lameness risk factors, which found that cows with a body condition score of more than 3.5 had 0.39 lower odds of being lame (Dippel et al., 2009).

Subsequent research has corroborated these findings and a strong association between body condition score and lameness found that thin cows are more likely to get lame (Lim et al., 2015; Randall et al., 2015), as body condition score affects the thickness and quality of the digital cushion (Bicalho et al., 2009).

## **Age**

Age is a significant factor with regard to the occurrence of lameness in dairy cows. Young first calving heifers experience an initial peak in lameness, as there appears to be a marked reduction in horn growth. The reduced growth leads to softer horn formation, causing weakening and possible separation at the white line, in addition to making them more prone to bruising, sole lesions,

sub clinical laminitis and haemorrhages when housed (Hobler et al., 2000; Tarlton et al., 2002). Young cows in early lactation are also more likely to suffer from Digital Dermatitis (Somers et al., 2005).

These individuals should be carefully managed as additional physical stress on the foot during the periparturient period may increase lameness risk (Webster, 2005).

Rowlands et al.(1985) found that susceptibility to lameness increased fourfold for cows over 10 years old and, in a later study, Huang et al. (1995) found that the risk for six different foot disease traits increased with age.

### **Breed**

Having a herd consisting entirely of a breed or breeds other than Holstein-Friesian was associated with a reduction in lameness prevalence compared to having a herd consisting entirely of Holstein-Friesians (Barker et al., 2010). Jerseys are associated with lower lameness levels, which have been attributed to their build. Jerseys are smaller than other breeds and therefore generally lighter cows, resulting in less pressure on the hooves without sacrificing the thickness of the digital cushion. Jerseys and Ayrshires also have better claw score traits for certain foot conditions than other breeds (Huang et al., 1995).

An early study by Chesterton et al.(1989) found the following:

- The Brown Swiss had the worst scores for corkscrew claws, laminitis and sole ulcers
- White line scores were worst in Guernseys
- Heel erosion and incidence of digital dermatitis were worst in Friesians
- Jerseys tend to have harder feet and less lameness.

The variations in lameness predispositions in each breed could be due to the claw colour, as cattle with less pigmented feet are more prone to lameness (Chesterton et al., 1989). Further research into this was undertaken by (Sogstad et al., 2011), whereby associations between the colour of the sole horn and claw disorders detected at claw trimming were investigated. Haemorrhages of the sole (HS) and white line (HWL) were more frequently found in light than in dark pigmented claws. Both HS and corkscrewed claws were slightly more prevalent among cows which had claws with mixed colour versus dark claws. It has been suggested that the composition of the darker coloured claws is much harder than light coloured claws, which provides a stronger barrier, protecting the corium from damage (Sogstad et al., 2011).

### **Environmental Factors**

The importance of a suitable environment for housing cattle is never more evident than when considering lameness. There have been over 80 potential lameness hazards identified attributed to the farm environment (Barker et al., 2010; Bell, 2005; Rodriguez-Lainz et al., 1999). An environment that predisposes lameness can lead to increased standing times, pooled slurry and in turn, an increase in the spread of digital dermatitis and other contagious diseases.

The surface a cow is housed on can also present a problem with hoof wear and re-growth. Concrete is abrasive and therefore causes hoof horn wear. The horn regrows, but often at a rate that is faster than it can be worn down again, and hooves often become unevenly overgrown. Each hoof comprises of two claws. The weight of the cow should be distributed evenly between the two claws.

The problem occurs when one of the digits, normally the outer claw, has an overgrowth of horn. This causes the outer digit to take more weight, which causes even more pressure to build on the edge of the pedal bone, which then translates to bruising and ulceration of the corium. To negate excessive horn growth, routine foot trimming of housed cattle should be undertaken to maintain correct horn levels (Archer et al., 2015). This demonstrates the need for good management practices in combination with an awareness of the effects animal and environmental factors have upon lameness.

Alternatively, if the concrete is not abrasive enough, there will be insufficient grip and cows will slip, causing more trauma related injuries including hock and ligament damage, sprains and strains.

Further environmental factors affecting lameness include season. The risk of an animal becoming lame is greater in winter than in summer (Cook, 2003a; Rowlands et al., 1983), most likely reflecting the fact that most dairy cows are housed in the winter, which puts increasing demands on hoof health. This is due to a number of reasons including, but not limited to; increased hoof wear due to excessive time spent on concrete, increased standing times and remaining in an environment conducive to bacterial growth (i.e. pooled slurry), and associated clinical diseases such as Digital Dermatitis (DD) (Klitgaard et al., 2014).

DD, interdigital dermatitis, and foot rot are the most prevalent infectious digital diseases in cattle (Logue et al., 2005; Teixeira et al., 2010) which account for 17-20% of all lameness cases (Blowey, 2005). Interdigital and digital dermatitis are both known to be among the most contagious and therefore hygiene-dependent foot diseases (Klitgaard et al., 2014; Murray et al., 1996). High



levels of bacterial are present in areas of poor hygiene, therefore ensuring a clean environment is crucial in tackling the disease.

DD bacterium has also been shown to remain on equipment being used to trim cows' hooves- potentially acting as a vector for transmission between animals and farms. In a recent investigation, foot trimming knives were tested after being used to trim DD symptomatic and asymptomatic cattle and after disinfection of the equipment. DD treponemes were shown to be present on 96% of knives after trimming a DD positive cow. Even after routine disinfection of foot trimming tools, DD treponemes were still detected on 29% of knives (Sullivan et al., 2014).

Housing type also plays a very important role in the level of lameness. The overall incidence of lesions was lower in straw yard accommodation (0.71 cases per 100 cows per month) than in cubicles with yards (0.93 cases per 100 cows per month). This is likely to be due to the reduction in excessive hoof wear and regrowth. Free stall housing has shown the highest rate of lameness compared with other dairy systems (Cook and Nordlund, 2009; Haskell et al., 2006). Housing design is critical in ensuring low levels of lameness, as lying times are directly related to lameness levels. Lamé cows stand on average, 1.75hr/day less than non-lame cows (Navarro et al., 2013). This results in less time at the feeding trough which could be a contributor to the reduced milk yield shown during a period of lameness (Green et al., 2002). A more recent Dutch study on 37 dairy farms, demonstrated that those housed in facilities with sand in the cubicles were less likely to be lame (Andreasen and Forkman, 2012) This confirms earlier evidence, which found that there is less lameness in systems where cattle are housed on deep bedded sand (Cook, 2003b).

Barker et al., (2010) also investigated risk factors associated with lameness, where 205 dairy farms were mobility scored and the commonly reported risks within the housing and grazing environment were recorded. The predominant housing related risk factors for lameness included; damaged concrete in yards, the use of automatic scrapers, sharp turns near the parlour entrance and/or exit and cows being housed for longer than 61 days at the time of scoring.

### **Management Factors**

The way in which a herd is managed can play a significant role in the health of the animals within that herd. It has been demonstrated that farms which opt for a zero grazing approach (a system where cattle are housed all year round) experience more lame cows than on grazing farms (Haskell et al., 2006). Lameness is less frequent in cows at pasture because they lie down for longer periods, taking pressure off of the hoof, and importantly, the pedal bone which, due to its shape, is known to cause sole ulcers if cows remain on their feet for long periods of time. Not only are standing times reduced at pasture, but when the cattle are standing, the ground is softer and is therefore not causing hoof wear and re-growth issues that are seen in housed animals.

Manure management and prevention of prolonged contact between feet and slurry is important as a preventive measure to control lameness, especially DD (Gregory et al., 2006). In theory, the more stockpersons there are in a system, the better a system should be managed. In a preliminary study investigating factors affecting the percentage of lameness in dairy cattle, this theory was tested and it was determined that those farms with one or less full time equivalent (FTE) stockpersons on farm, see higher (although not significant) levels of lameness (Shepherd et al., 2012).

The use of foot trimmers has also been documented to have an effect on lameness levels (Enevoldsen et al., 1991). If feet are trimmed when the cow is dried off the risk is less (Ward, 1999). Routine foot trimming is intended as a preventative measure to maintain and improve the shape of the hoof, in order to maintain equal weight bearing across the hoof. Due to the abrasive nature of concrete that dairy cattle are housed on, often this shape becomes distorted, causing pressure points on the hoof that become ulcers if not correctly treated. Correct management after foot trimming also has an effect on lameness. If cows are driven along stony tracks just after their feet have been trimmed, there is a greater risk of them becoming lame, because the hoof has had the harder outer layer removed, which leaves the sole prone to bruising and punctures from stones until the sole hardens.

Correct management of newly calved cows is also important as there is evidence that low dominance-ranked cows spend less time lying down than high-ranking animals, leading to higher lameness risks (Galindo and Broom, 2000). Foot lesions have also been related to the early post-calving period. At and around calving, cows are subject to immunosuppression and may have an increased standing time which may predispose to foot lesions and lameness (Chaplin et al., 2000). Correct management around these high risk times could prevent and reduce lameness.

## Lameness Conditions

Currently, the diseases of major significance in lameness incidence in the UK are digital dermatitis, sole ulceration and white line disease. A similar picture has been shown in the US, a survey of eight confinement dairies recorded digital dermatitis as the cause of 48% of all lameness, sole ulcer as 21% and white line disease as 17% (DeFrain et al., 2013). Over 90% of lameness involves the foot, with leg injuries being far less common. Foot problems are most often seen in the outer digit of the hind feet as these are the main weight bearing areas.

### Digital Dermatitis

Digital Dermatitis (DD) is the most common skin disease of the foot, which is often associated with housed animals. DD is a contagious inflammation of the epidermis, which often presents as erosive or proliferative lesions on the heel, coronary band area, between the claws, in the interdigital space or below the dew claws (see Figure 2). The lesions are extremely painful and, when left



**Figure 2.** Digital Dermatitis lesion on the heel, below the dew claw. (NADIS, 2016).

untreated, results in a chronic irritation reaction of the skin. It has been estimated that DD is in 71% of UK herds, (NADIS, 2016) and that 17-22% of all lameness cases are due to DD (Blowey, 2005). Before treatment, the cost of DD for a 150 cow herd ranges from £6,500-£14,000 (Bennett and Cooke, 2005). This demonstrates the significant detrimental effect DD has on the cost of milk production (Losinger, 2006).

Effective prevention and treatment for DD is with a walk through stationary foot bath, where 5-10% zinc or copper sulphate or antibiotic solution can be used to kill the DD treponemes. (Laven and Hunt, 2002) found that a seven day non-antibiotic footbath treatment was just as effective as a two day antibiotic treatment. Formaldehyde can also be used alongside copper sulphate, as this has the dual purpose of neutralising DD treponemes, whilst also hardening the hoof. This reduces the likelihood of bruising and sole ulcers developing. Foot-bathing should be undertaken during periods of risk, such as early lactation and especially during the autumn and winter housing period.

Housing animals on straw yards also reduce the exposure to bacteria causing DD (Laven and Logue, 2006).

### Sole Ulcer

Sole ulcers are typically found in the rear third of the outer claw hind foot, as



**Figure 3.** Sole Ulcer. Classic position and appearance. (NADIS, 2016).

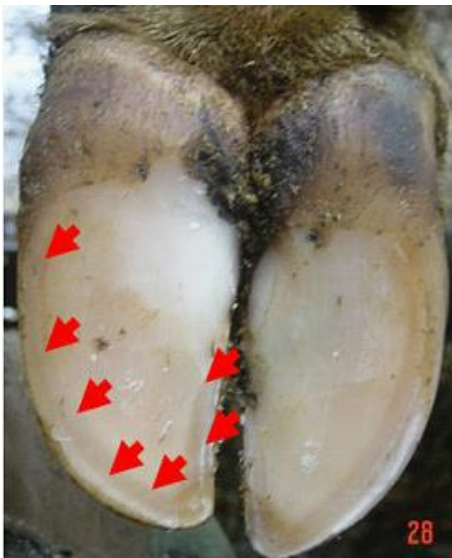
this is the main weight bearing area (see Figure 3). Abnormal claw shape has been strongly associated with sole ulcers (Manske et al., 2002). The abnormal claw shape develops through atypical wear that occurs when cattle are housed on abrasive surfaces, such as concrete. The regrowth of horn can be greater than the wear, or vice versa, which causes weight distribution imbalances between

both claws. This uneven weight causes bruising and ulceration due to excessive pressure through the pedal bone on the sole corium.

Other conditions, such as laminitis can also cause the pedal bone to drop, which can damage the corium, resulting in bruising and the formation of a sole ulcer. Sole ulcers sometimes appear as a haemorrhage, with a softening and yellowing of the horn, progressing to necrotic tissue and often infection. Lumps of proud flesh, granulation tissue, may protrude from the ulcer area. Sole ulcers are extremely painful, and cows typically appear severely lame when they have this condition. It is very difficult to successfully treat sole ulcers, and many never fully heal. Indeed, some cows may suffer from chronic lameness for the rest of their lives (Blowey, 2005). Prevention is most certainly better than cure, and therefore prevention should be aimed at maintaining correct claw shape through routine foot trimming.

### White Line Separation

The white line is the site at which the horn of the wall of the hoof joins that of the



**Figure 4.** The arrows indicate the White Line, where the wall joins the sole.

sole (see Figure 4). It is a naturally weak area in the horn and cracks can allow dirt and bacteria to enter, causing abscess formation, pain and lameness. The initial weakness in the white line may be a result of laminitis, abnormal conformation and possibly dietary effects. These effects can be multiplied

when cattle are housed, as the twisting and turning forces applied to the hoof when on

concrete can cause white line separation. This can then develop an infection or abscess. Restrictions of trough space in yarded cattle may also predispose the condition.

## **Lameness Prevalence**

Herd prevalence rates can vary hugely between farms because, as mentioned, many factors can predispose clinical lameness due to differences in stockmanship, animal factors and farm environments (Vaarst et al., 1998). However, the most recent lameness prevalence in the UK was reported to be 36.8% (Barker et al., 2010). Further preliminary data for the south west of England (Cornwall, Devon, Dorset, Somerset, Wiltshire and Gloucestershire) indicated lameness prevalence of 26.5% (Shepherd et al., 2012), which is below the last reported national average lameness prevalence.

In 2010, (Barker et al., 2010) surveyed 205 dairy farms across England and Wales and reported a mean lameness prevalence of 36.8%. This figure is higher than earlier studies; for instance, an incidence rate of 24% lameness was reported in a DAISY survey of 90 herds sampled in 1992-1993 (Esslemont and Kossaibati, 1996) During 1995-1996 Kossaibati and Esslemont (1999) reported 38% lameness on 50 farms, whilst it was reported to be 22% incidence based on data from 434 UK dairy herds (Whitaker et al., 2004).

Lameness prevalence in the UK has fluctuated over recent years. The number of cases decreased from 23.3% in 1998/99 to 20.7% in 2000/01 but then subsequently increased to 21.9% in 2001/02. Studies have shown that the UK seems to have a much higher rate of lame animals than some other countries. Lameness prevalence in Sweden was at a much lower level of 5% in a 2002 study, which also showed the USA to have a lower lameness incidence of 13.7%-16.7% (Manske et al., 2002).

Surveys of organic dairy herds have reported a lameness prevalence of 18% in German herds, with a higher incidence in cubicle housed herds (Binkmann and

Winckler, 2004) and 24% in UK herds (Huxley et al., 2004). Herd prevalence rates can also vary across organic and conventional farms because many factors can predispose clinical lameness and because of differences in stockmanship and farm environments (Vaarst et al., 1998).

The continuing rise in lameness prevalence in the UK is worrying and must be addressed in order to keep welfare standards high and remain competitive in what is now a global market.

The measures being taken by British farmers are clearly not improving the occurrence of lameness as these figures and the percentages show an increase in lameness from 2000 to 2002; this is undoubtedly connected to the unprecedented increase in milk yields over this period. Therefore it is critical that further research and recording of lameness cases needs to be carried out to inform farmers' decisions to improve these figures.

### **Lameness Detection**

Despite ongoing research into the lameness in cattle and improvements in the accuracy of lameness scoring techniques and efficacy of treatments, evidence suggests that the incidence and prevalence of lameness continues to rise (Barker et al., 2010).

The importance of rapid identification and treatment of lame cows was illustrated using the reaction of an animal to a noxious stimulus (Whay et al., 1997). The authors' findings demonstrated the importance of field observations and early identification and treatment of lame cows. (Whay, 2002) identified the use of mobility and locomotion scoring methods as a tool to monitor both individual and whole herd lameness levels, in order to reduce the level of



lameness, and in turn, reduce the associated costs. The benefits of mobility scoring include;

- a. Early identification of lame animals resulting in prompter treatment (Barker et al., 2010)
- b. Identification of cows that are mildly lame, encouraging farmers to treat the mild cases before they potentially turn into more severe and expensive cases of lameness.
- c. Monitoring and clear target setting for lameness reduction can be set.

The demand for an accurate and repeatable recording system that both professionals and non-professionals can use to record lameness has emanated from pressure within the industry. This is demonstrated by one of the objectives of the British Cattle Veterinary Association (BCVA) dairy herd health plan to 'create and maintain a record of lameness which will allow the assessment and monitoring of the incidence and prevalence of lameness in the herd'.

In addition, retailers and milk buyers are beginning to alter their contractual agreements with farmers, by building mobility scoring as a requirement into their contracts. One milk processor asks members to score their herd every two months, keep a record of the scores, formulate an action plan and arrange for a suitably qualified person (SQP) to visit their farm and score their herd on an annual basis.

In 2007, Bell and Huxley identified a need to standardise a single scoring method that could be used throughout the industry by both professionals and non-professionals, as the number of widely different scoring methods had

previously created confusion amongst farmers and the wider industry. Through consultation with a cross-industry group of veterinarians, consultants, academics, foot trimmers and milk buyers, the DairyCo mobility score was developed. This method remains the UK industry standard since its inception in 2009.

The DairyCo mobility score is based upon a four point scoring system, with cows scoring score 0 being of perfect mobility, 1- imperfect mobility with no clearly identifiable lame leg, 2- lame with an identifiable leg and 3- severely lame (See Appendix A.). Cows scoring two or three are classed as lame and action is required. Lameness prevalence is expressed as a percentage and is calculated by totalling the number of score 2 and 3 cows and dividing by the total number of animals scored. It can be expressed as a fraction or as a percentage. It is advised that, in order to provide comparable results and improve inter-observer reliability, the same scorer is used each time.

The reliability of mobility scoring came into question, through work by (Tadich et al., 2010). In this investigation, cows from 91 herds in Chile were locomotion scored using the (Sprecher et al., 1997) scoring method. Their feet were then examined for lesions. The lesions linked to poor locomotion were sole ulcers, double soles and interdigital purulent inflammation. However, several lesions were found in cows which had achieved a low mobility score i.e. no observable lameness. It was concluded that the presence of a lesion was not always a precursor to a poor mobility score. This is an important area of research, as it suggests that mobility scoring alone is not sufficient to identify all lame cows.

Observer reliability has also come under scrutiny; however, in an investigation into an evaluation of lameness scoring systems, Thomsen et al. (2008) came to

the conclusion that although the lameness categories used in the investigation were not equidistant, the scoring system had a reasonable level of reliability in terms of intra- and inter-observer agreement. This concurred with a previous study on assessing horse lameness (Fuller et al., 2006), which also confirmed that it held up to this scrutiny by demonstrating good intra-assessor reliability.

In more recent research, external factors such as lighting and walking surfaces have been shown to have an effect on perceived observational mobility scores. Cattle walking in dark, damp and slippery environments tend to take shorter asymmetrical strides, which would indicate lameness. However, upon closer inspection, many were deemed non-lame. This indicates that the scoring environment has a direct effect upon the way the animal walks, and that false lame observations can, and will, occur in observational mobility scoring (Van Nuffel et al., 2015).

Future developments in the improvement of lameness scoring, include research in using force plates and artificial intelligence (such as computer generated data and classification based on algorithms) to determine whether or not a cow is lame (Ghotoorlar et al., 2012). In another study, infrared thermometry was used to monitor foot temperatures of 990 dairy cows, fortnightly for six months. They found that various lesions were associated with different temperatures, and hoof temperature was elevated six weeks prior to any behavioural signs. (Wood et al., 2015). This is important as, pre-empting clinical signs of lameness and treating immediately could reduce lameness significantly.

The use of artificial intelligence and technology removes inconsistencies between observers, and could potentially negate the issue of false positives, however the cost and practicality is prohibitive in most instances.

Despite questions raised about the reliability of mobility scoring, it must be remembered that the mobility scoring system has only been developed and put into practice within the industry relatively recently. The need for a low cost, accurate and repeatable way of determining herd lameness levels has been achieved with the introduction of mobility scoring and the current industry accepted Dairy Co method, not only helps to identify lame cows, but also increases farmer awareness of lameness. This increased farmer awareness alone, should result in a reduction in the prevalence of lameness, and is certainly a step forward in reducing lameness incidence.

After consideration by industry professionals, farmers and policy makers, the DairyCo mobility score was adopted by the Healthy Livestock Scheme as the standardised scoring method. The mobility score needed to be able to be undertaken by a wide audience; vets, veterinary technicians, farmers, farm workers and consultants. Not only that, but the results had to be useful for the farmer. Farmers across the country are aware of the DairyCo mobility scoring system, and to introduce another system that is more technical and less repeatable (in terms of ease), would only hamper future engagement and farmer progression. Not only that, but the more accurate lameness detection techniques come at a significantly greater cost. It is not realistic, for example, to install force plate and infrared monitors on every farm in the Healthy Livestock Scheme.

### **Farm Assurance Schemes**

In the UK, Farm Assurance Schemes are widespread. Farm Assurance Schemes are voluntary schemes (although increasingly dairy processors are moving towards making this a contractual condition) that producers can join in

order to assure consumers that they have achieved certain standards throughout the production process- from welfare, through to safety and environmental factors. Each scheme has its own requirements in order to achieve certification. These requirements vary depending on the aim of the scheme.

The RSPCA's Freedom Food scheme is one such scheme which has been in effect since 1994. It was established to act as an indicator for higher welfare farm assurance and as a food labelling tool allowing consumers to identify high welfare produce. In order to achieve Freedom Food accreditation, a farm must undergo regular inspections to ensure compliance with the Freedom Food requirements.

An investigation into the effectiveness of the Freedom Food scheme found that although there were improvements in some welfare indicators, there were poorer results for others and that overall there was no significant difference between Freedom Food farms and non-Freedom Food farms (Main et al., 2003).

The Farm Animal Welfare Council (FAWC) identified the importance of farmers in maintaining an acceptable level of animal welfare (FAWC, 2009). The FAWC agreed that lameness in dairy cattle is best tackled by improvements in management and careful choice of breeding stock. Education and training of stockmen, driven by a desire for self-improvement, the demands of assurance schemes, or incentive payments by processors in the food supply chain, are all means to implement change.

## **Farmer Engagement**

In order to make improvements in animal welfare, there needs to be a sustainable change which is acted upon by the farmer. To promote change, there needs to be an understanding of dairy farmers' motivations and the barriers towards engagement. These barriers and motivations were investigated in two important pieces of research by (Leach et al., 2010a, 2010b). In the investigation looking into barriers faced by farmers, 222 dairy herds were mobility scored by para-professionals [persons specially trained in a particular field or occupation to assist a veterinarian (Blood et al., 2006)], mobility scorers and the farmers' perceived level of lameness was compared with the actual level of lameness. A questionnaire was also used to explore the barriers facing lameness control. The results were surprising. Despite the average lameness prevalence being 36%, a surprising 90% of farmers did not perceive lameness as a problem. The limiting factors given for lameness control were; time, labour and financial constraints. This investigation identified a need to improve farmers' understanding of the implications lameness has for the farm business and for welfare. It also highlighted a need to address the limiting factors farmers provided as barriers for engagement.

In the subsequent investigation by (Leach et al., 2010a), the same farms answered a questionnaire on their motivations for lameness control. The predominant answer for farmer motivation for control that pride in a healthy herd was 'very important' or 'extremely important' to them, closely followed by feeling sorry for lame cows with a rating of 81%. The least important factors which motivated farmers to control lameness were 'having less lameness than other herds' and 'the risk of lame cows affecting farm accreditation'. This is

important as maintaining a good public image for dairy farms is likely to be one of the stronger external drivers to push forward lameness control.

In a further investigation into promoting farmer engagement and activity in the control of lameness, farmers were given varying levels of support through the process of formulating and adhering to an effective lameness control plan. Action points that were likely to compromise lameness control were reduced when farmers had the support of a veterinarian or facilitator. Overall, farmers participating with facilitator and veterinary support improved the effectiveness of their control plan (Whay et al., 2012).

### **Health Intervention Schemes**

Health intervention schemes are introduced in order to reduce and control diseases. Often, these schemes are structured so that the individual progresses through a series of stages which have the result of reducing disease. Recently, health intervention schemes have been used successfully to control and in some cases, eradicate diseases within the livestock industry. This has been shown in the eradication of Bovine Viral Diarrhoea (BVD) in Switzerland (Presi et al., 2011) and in Shetland (Synge et al., 1999). For this reason, there have been several health intervention schemes implemented to improve lameness, with mixed results being achieved.

An investigation into a lameness control programme showed that intervention was generally ineffective. This lack of success was attributed largely to poor compliance with the scheme (Bell et al., 2009). In cases of poor compliance with a health intervention scheme, 30% was due to time, labour and financial constraints (Leach et al., 2010b).

A more recent investigation into the effectiveness of engagement deemed that the use of a facilitator resulted in greater participation, and therefore greater impact was achieved (Whay et al., 2012).

In 2009, The Healthy Livestock Scheme was developed as an initiative focussed on controlling the incidence of mastitis, lameness, BVD, Johne's disease and respiratory diseases in cattle and lameness, nutrition, breeding and parasite control in sheep. The scheme was rolled out across the six counties in the South West of England; Cornwall, Devon, Dorset, Somerset, Wiltshire and Gloucestershire, and provided up to 70% Rural Development Programme for England (RDPE) funding for farmers towards veterinarian and adviser consultations, diagnostic tests, farmer discussion groups and a programme of training events. Farmers had the option of participating in any of the strands. The lameness strand, which was based on the development work carried out by the University of Bristol (Leach et al., 2010b; Main et al., 2012), involves several optional one-to-one veterinarian visits to farms, offering specialist, individual advice on improving lameness, as well as the opportunity for the farmers to attend lameness workshops and foot trimming courses. The farmer decides with an interaction with their vet, which stages would be of benefit.

As Leach et al (2010) indicated, finance is a barrier to farmer engagement. The Healthy Livestock Project has addressed this issue by offering 70% funding towards the cost of these activities, as an additional incentive for farmers to participate. The farmer contributes 30% of the cost and the Healthy Livestock Scheme pays for the remaining 70%.

In order to produce comparable data that could be analysed in order to determine either an increase or decrease in the prevalence of lameness,



compulsory mobility scoring, using the DairyCo mobility scoring method, was undertaken at the start of the scheme as well as a year later, ensuring that the same person scores the herd each time.

The recently launched DairyCo Healthy Feet Programme further builds upon the regional Healthy Livestock Scheme to create a national lameness reduction and control scheme, with a similar emphasis on a mentoring system.

## **Chapter Four**

### **Aim**

In order to gauge the effectiveness of the Healthy Livestock Project, the following objectives have been developed for investigation in this thesis.

1. Identify any change in the incidence of lameness between the initial and final mobility scores.
2. To investigate whether the independent variables affect the level of change.

### **Hypotheses**

The following hypotheses have been formulated in relation to the objectives;

1.  $H_0$ : There will be no change in the incidence of lameness between the initial and final mobility scores  
 $H_1$ : There will be a significant change in the incidence of lameness between the initial and final mobility scores.
2.  $H_0$ : The independent variables will not affect the level of lameness within a herd.  
 $H_1$ : The independent variables will affect the level of lameness in a herd.

## **Chapter Five**

### **Materials and Methods**

#### **Data Collection**

Data were collected through the Healthy Livestock Project, a Rural Development Programme for England (RDPE) funded health intervention scheme aimed at improving animal health by reducing disease. This programme was implemented across the six counties of the southwest of England (Cornwall, Devon, Gloucester, Somerset, Wiltshire and Dorset) from November 2010- January 2014. Duchy College Rural Business School was responsible for managing the funding, delivering the project on time and targeting the number of farmers required.

In order to do this, Duchy College enlisted the help of large animal veterinarians to act as subcontractors who deliver the scheme to their farmers. Before commencement of funded delivery, Healthy Livestock invited all large animal veterinary practices in the southwest to attend various training events in order to deliver funding to farmers through the Healthy Livestock (HL) scheme. A one-day Healthy Livestock lameness training session instructed veterinarians and para-professionals on the use and on farm application of the DairyCo mobility score as well as a briefing of the Healthy Livestock funded lameness programme, with an emphasis on the veterinarian acting as facilitator to enable the farmer to make decisions on lameness control. Once completed, attendees were deemed eligible to deliver the specified programme of funded lameness training (Appendix B) to farmers across the southwest of England.

A total of 103 veterinarians and para-professionals, from 59 veterinary practices and organisations across the southwest, attended the training and were eligible to deliver the lameness funding in the southwest.

In order for farmers to participate in the lameness strand of the Healthy Livestock Project, an initial mobility score (before any training had taken place) and a final mobility score (after all training had been completed) was required to be undertaken on their farm by an approved mobility scorer. Mobility scoring was carried out by participating veterinarians or para-professionals that attended the HL lameness training.

The DairyCo mobility score scale, the nationally accepted method of lameness scoring cattle in the UK, was used to score every cow in the milking herd from a score of 0 (sound and perfect mobility) through to 3 (severely lame). The number of cattle scoring scores two and three were then expressed as a percentage of the whole milking herd, and the results fed back to both the farmer and to Duchy College Rural Business School's Healthy Livestock team.

As per DairyCo guidelines, it was advised that the same individual undertake both the initial and final mobility score, in order to ensure inter-observer reliability and thus reduce observer bias; however this procedure was not always achieved. The reasons behind this were not recorded, but could be due to veterinary time constraints.

In addition to the mobility score data, a farm information questionnaire (Appendix C) was completed for each farm. This enabled information such as farm size, number of full and part time employees, farming system, housing system, number of cattle and the main breed to be logged. The questions on the farm information questionnaire were predetermined by an online herd health

programme called myhealthyherd.com. Information such as 'Farm Type' was already pre-classified into 'Standard, Intensive or Organic' by myhealthyherd, and there was no option to alter these classifications. This was because all data from the project had to be fed directly into myhealthyherd in order to record the results across the whole of Healthy Livestock Scheme, not just for the lameness strand of the scheme.

Once the veterinarian or para-professional had completed the initial mobility score visit, an interaction between the veterinarian and farmer decided which stages of the lameness strand would be of most benefit to the farmer. The lameness strand was not rigid in structure, in that participants could select which aspects they would like to undertake. Due to the nature of stages 3, 4 & 5 of the Healthy Livestock lameness strand, this was only open for veterinary surgeons (recognised by the Royal College of Veterinary Surgeons (RCVS)) to deliver, not para-professionals.

Each time the veterinarian visited the farm to undertake a stage of the Healthy Livestock lameness strand, the veterinarian would report back to The Rural Business School, to claim for funding. This allowed an opportunity to record which, and how many stages the farmer had completed.

### **Sample Frame**

All dairy farmers in the southwest of England had the opportunity to engage in the lameness programme either through their own large animal veterinarian (who had attended the lameness training) or, through another eligible deliverer—such as Duchy College's in-house para-professional mobility scorers, all of whom had attended either the DairyCo mobility scoring training or the Healthy Livestock lameness training, which incorporated mobility scoring training.

This ensured that no farmer was excluded from the programme due to lack of engagement by their veterinarian.

### **Sample Size**

The initial sample size comprised 496 farms. The raw data were collated and input into a Microsoft (MS) Excel spreadsheet where they were cleaned in preparation for statistical analysis. Farmers were contacted if there was any missing information, and the gaps filled in if possible. Only 179 (36%) of the initial sample returned complete data and were subsequently used in the analysis. The majority of incomplete data sets were due to veterinarians or para-professionals not completing a final follow up mobility score. This could be due to the relatively small amount of money the veterinarian is paid to carry out a mobility score, the relatively short time period of the project (three years) or, in line with previous research into barriers facing progression through a health intervention scheme (Bell et al., 2009; Leach et al., 2010b), the farmer could have disengaged from the programme.

### **Statistical Analysis**

A preliminary investigation reporting descriptive farm parameters and observed levels of lameness was undertaken. The dependent variables tested were the initial mobility score, final mobility scores and the change between the two scores. The independent variables tested were breed, herd size, farm size, farming system, housing system and number of full or part time staff working on the farm.

Data were input into the statistical analysis package, Minitab 17. The distribution of the data from the dependent variables (initial mobility score and

final mobility score) were analysed to determine whether it was normally distributed using the Anderson- Darling test for normality. Both the initial and final mobility scores were normally distributed.

In order to determine whether there was a significant change between the initial and final mobility scores, a paired t-test was undertaken.

Further to the t-test, a General Linear Model (GLM) was used to discover whether the independent variables had a statistically significant effect upon the dependent variables (initial mobility score, final mobility score and the change between initial and final mobility scores). In order to undertake the GLM, herd size had to be re-categorised into, 'Less than average' and 'More than average', as there were too many different data values to produce a valid result. Average herd size was determined using the national average herd size, from (AHDB Dairy, 2015).

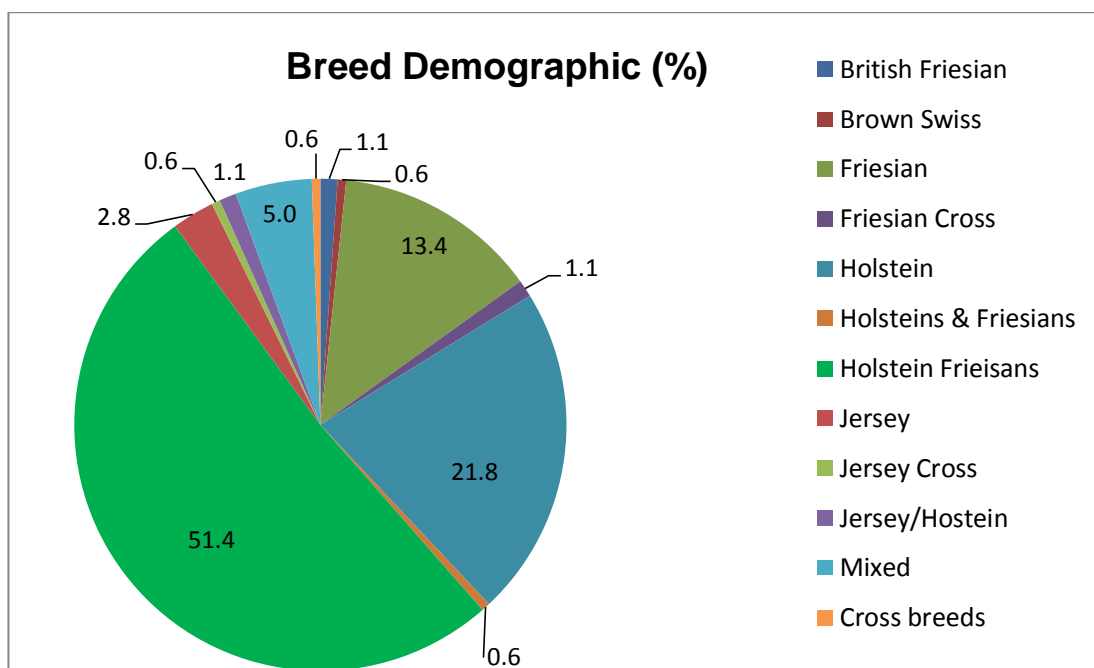
Any significant values from the GLM were further explored using Tukeys post hoc comparisons.

## Chapter Six

### Results

#### **Descriptive Statistics**

The mean farm size for the sample (n=179) was 177ha with a standard error of  $\pm 124$ . The mean ranged from 33ha to 809ha. The mean herd size was 228 cattle ( $\pm 126$ ) ranging from 50 to 800 cows. There were a variety of different breeds, (see figure 5), but the majority (51.4%) were Holstein Friesians.



**Figure 5.** Pie chart showing the breed demographic of farms participating in the Healthy Livestock Scheme.

The predominant housing type on farms taking part in the Healthy Livestock Scheme was 'Freestalls or Cubicles', accounting for 69.8% of types, and a mixture of freestalls and yards were second most common (Figure 6). Standard farming systems were most common in the data set, at 77.1% of the total (Figure 7). The number of full time staff working on farm was on average, between three and four FTE's (Figure 8).



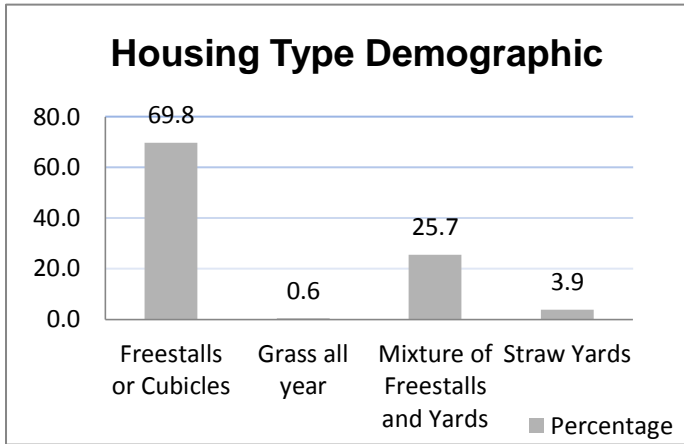


Figure 6.

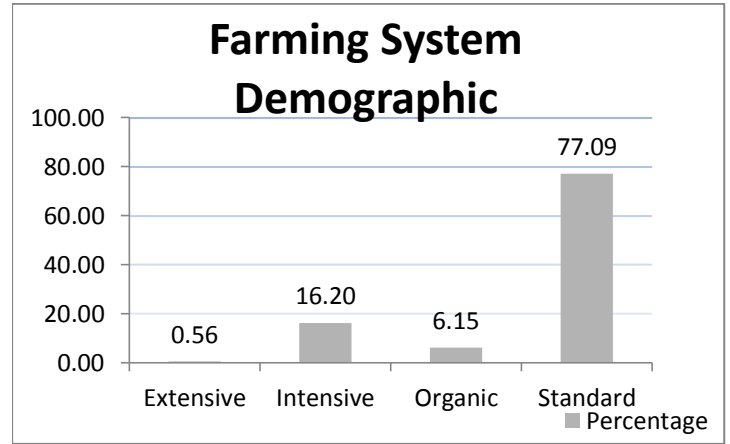


Figure 7.

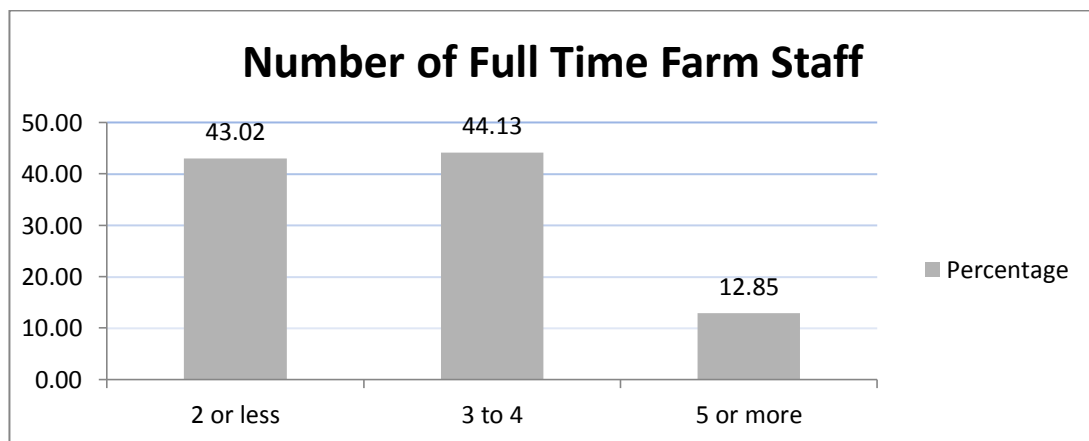


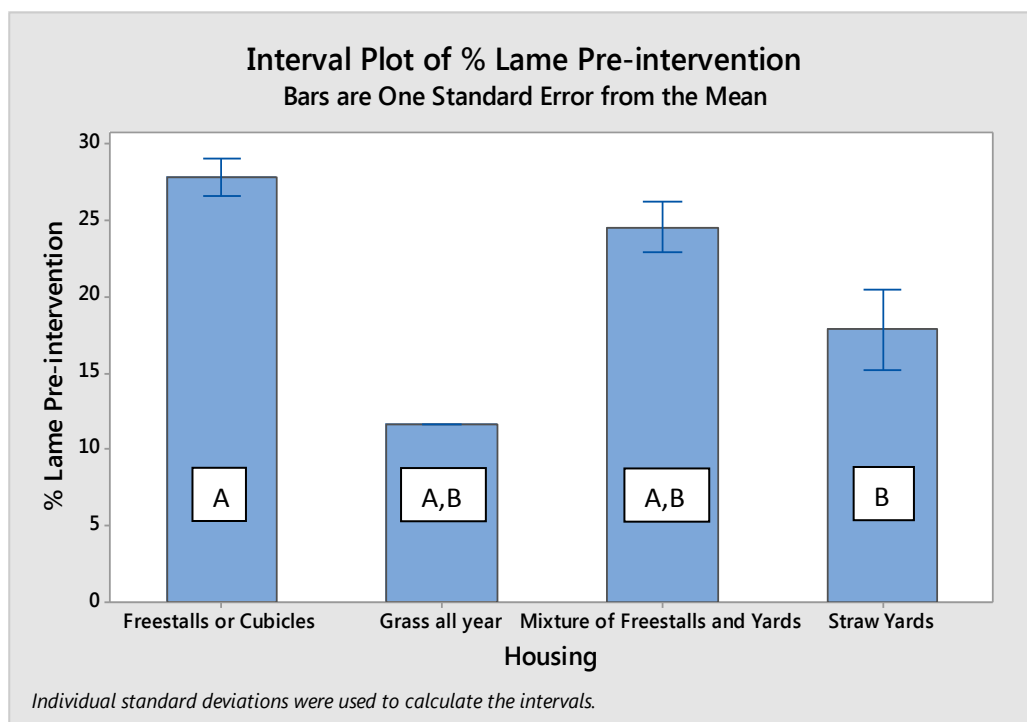
Figure 8. Number of FTE's

Pre-intervention lameness prevalence for the sample (n=179) was 26.7% ( $\pm 13.3\%$ ), ranging from 3% to 63%. Post-intervention herd lameness prevalence for the sample (n=179) was 20.4% ( $\pm 10.8\%$ ), ranging from 3% to 58%. The average (mean) change between the pre-intervention lameness prevalence and post-intervention lameness prevalence was -6.27% ( $\pm 11\%$ ), ranging from a 52.37% reduction to a 22.95% increase in lameness levels.

Using a paired t-test the difference between pre and post-intervention lameness was analysed and an overall mean reduction in lameness prevalence of 6.27% was found to be statistically significant ( $p < 0.001$ ,  $t = 3.231$  DF=19).

### **Analytical Statistics**

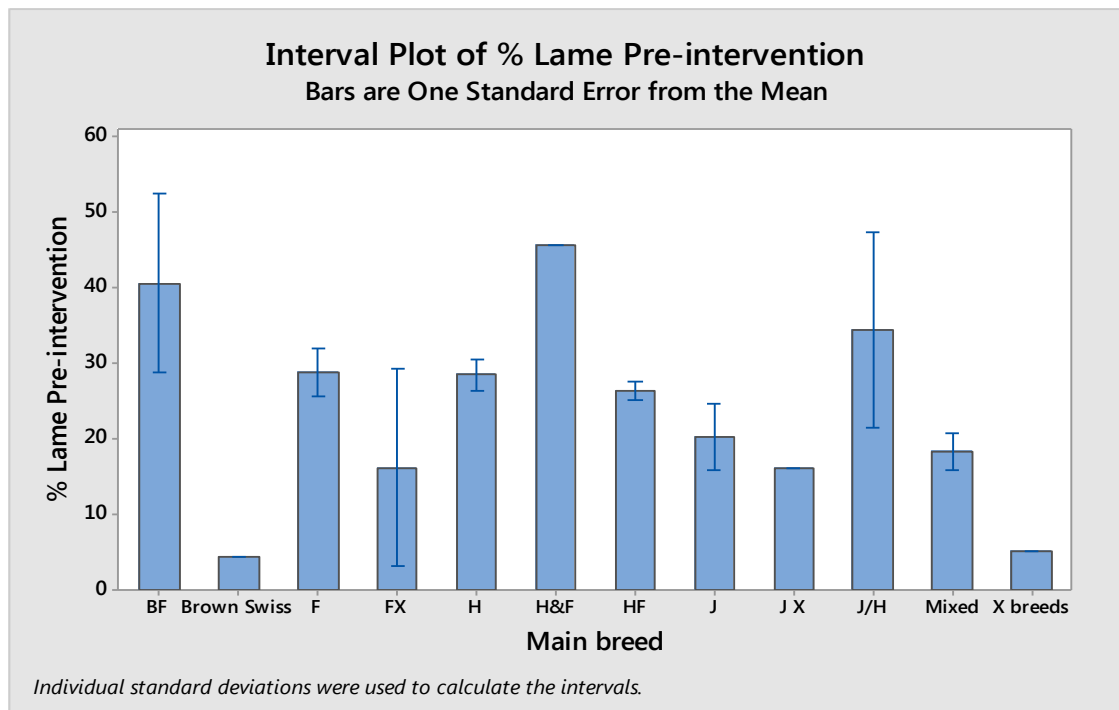
Taking into account all independent variables, a GLM was undertaken on pre-intervention mobility scores. There was no significant effect of farming system ( $F_{3, 156}=2.63$ ;  $p>0.05$ ), herd size ( $F_{2,156}=1.78$ ;  $p>0.05$ ), and number of stockpersons ( $F_{2,156}=1.88$ ;  $p>0.05$ ) upon the initial level of lameness. However, there was a significant difference between housing systems ( $F_{3,156}=3.46$ ;  $p<0.05$ ). After undertaking Tukeys post-hoc comparison, freestalls or cubicles demonstrated significantly higher initial lameness levels than straw yards (see Figure 9).



**Figure 9.** Interval Plot of % Lameness Pre-intervention Mobility Score.

*Means that do not share a letter are significantly different.*

There was a significant difference between breed and the initial mobility score ( $F_{12,156}=2.06$ ;  $p<0.05$ ), and although the graph indicated significant differences across breeds as a whole, after undertaking Tukeys post-hoc analysis, no discernible breed was significantly different from another, (see Figure 10).



**Figure 10.** Interval Plot of Percentage Lamé, Pre-intervention for Breed Demographic

BF= British Friesian  
 BS= Brown Swiss  
 F= Friesian  
 H= Holstein  
 H&F= Holstein and Friesians  
 HF= Holstein Friesians  
 J= Jerseys  
 JX= Jersey Cross  
 J/H= Jersey/Holstein  
 Mixed= Mixed breeds  
 X Breeds= Cross breeds

Taking into account all independent variables, a GLM was undertaken on post-intervention mobility scores. There was no significant effect of farming system ( $F_{3,157}=1.07$ ;  $p>0.05$ ), herd size ( $F_{1, 157}=0.32$ ;  $p>0.05$ ), housing ( $F_{3,157}=1.06$ ;  $p>0.05$ ), and number of stockpersons ( $F_{2,157}=1.68$ ;  $p>0.05$ ). Once again, there was a significant effect of breed upon the post-

intervention mobility score ( $F_{11,157}=2.56$ ;  $p>0.01$ ), and after undertaking Tukey Comparisons, the results showed no significant difference between breeds. However, the graph, could be interpreted that there are differences between breeds (see Figure 11)

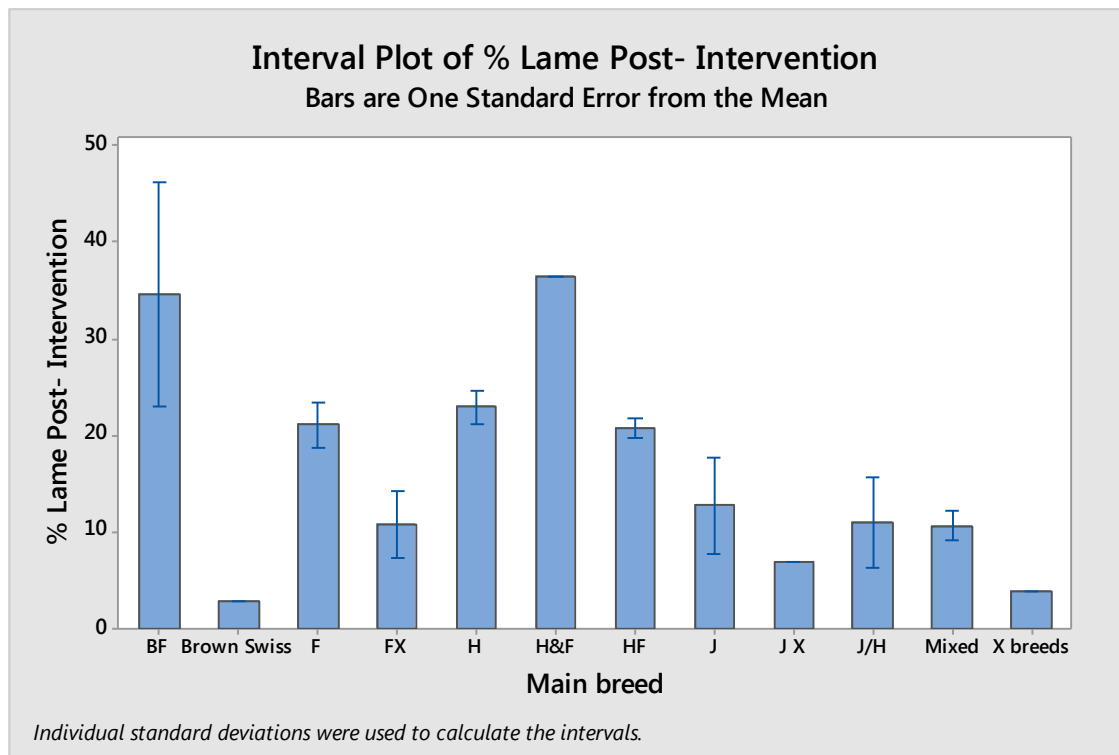


Figure 11. Interval Plot of % Lame Post-Intervention for Breed Demographic

BF= British Friesian  
 BS= Brown Swiss  
 F= Friesian  
 H= Holstein  
 H&F= Holstein and Friesians  
 HF= Holstein Friesians  
 J= Jerseys  
 JX= Jersey Cross  
 J/H= Jersey/Holstein  
 Mixed= Mixed breeds  
 X Breeds= Cross breeds

Finally, taking into account all independent variables, a GLM was undertaken the change between mobility scores. There was no significant difference between herd size, ( $F_{1,158} = 2.35$ ;  $p > 0.05$ ), main breed ( $F_{12,158} = 0.64$ ;  $p > 0.05$ ), farming system ( $F_{3,158} = 1.57$ ;  $p > 0.05$ ), housing ( $F_{3,158} = 1.83$ ;  $p > 0.05$ ) and number of stockpersons ( $F_{2,158} = 0.14$ ;  $p > 0.05$ ).

## **Chapter Seven**

### **Discussion**

The initial aim of this research was to determine if the Healthy Livestock scheme had an impact upon lameness levels in the South West of England. The results of the paired t-test confirm there has been a significant reduction in lameness, from an average 26.7% lame to 20.4%. This means there was on average, 23.6% fewer cases of lameness after farms had participated in the Healthy Livestock Scheme, than before. In an average 128 cow herd, this equates to seven fewer cows becoming lame each year and, based on a conservative estimate of a single case of lameness costing £180 (AHDB, 2016), represents a significant saving of £1,283 per annum. This finding concurs with previous research that demonstrates farmers participating with facilitator and veterinary support improved the effectiveness of their control plan, and in turn, reduced lameness (Whay et al., 2012).

Further to this, it is possible to reject the null hypothesis that there will be no significant change in lameness levels after intervention, and instead, accept the alternative hypothesis.

Previous research indicated that farm variables such as breed, herd size and the number of FTEs working on the farm, all have an effect on the likelihood of becoming lame (Barker et al., 2010; Shepherd et al., 2012). However, after analysis, it was evident that there was no significant influence of housing system, herd size or the number of FTEs on either the pre or post-intervention lameness prevalence or the change in prevalence ( $p > 0.05$ ), so we can partially accept the null hypothesis that farm variables will have no effect on lameness prevalence.

The null hypothesis is only partially accepted as, concurrent with previous research, breed had a significant effect upon lameness prevalence (Barker et al., 2010; Chesterton et al., 1989; Huang et al., 1995; Shepherd et al., 2012). The GLM indicated there was a significant difference between breed and the pre-intervention mobility score and post-intervention mobility score. However, despite this, after undertaking Tukeys post-hoc analysis, no discernible breed was significantly different from another. In practice, these results should be interpreted with caution, as no significance is not the same as no difference. For example, Figures 10 and 11 indicate differences amongst breeds that support findings by (Chesterton et al., 1989) that Jersey cattle have lower lameness levels than Holstein Friesian.

Importantly, none of the independent variables had a significant effect upon the change in lameness seen between pre and post-intervention mobility scores. This is important as, it means that the Healthy Livestock scheme was effective at reducing lameness regardless of farming system, breed, herd size, housing, or number of FTEs. The wider implications of this mean that, crucially, this type of funded vet and farmer interaction reaps benefits for all farm types, regardless of these factors.

In addition to these outcomes, this investigation has provided some updated lameness prevalence figures for the South West of England. Lameness prevalence has fluctuated significantly over the years, but the most recently reported lameness prevalence in the UK was 36.8% in 2010, (Barker et al., 2010). In this investigation, using data from pre and post-intervention mobility scores, overall mean lameness prevalence was determined to be 23.6% in the South West of England.

## **Limitations**

One of the limitations of this study is that the time frame between the pre and post intervention mobility scores varied significantly. The Healthy Livestock scheme asked vets to complete a the final mobility score one year after the initial mobility score to account for the seasonal variations of lameness prevalence within a year. However, often this did not occur, and herds were mobility scored at different times of the year. Previous research has indicated that lameness levels fluctuate throughout the year and farms are more likely to have a higher prevalence in winter than in summer (Cook, 2003a; Rowlands et al., 1983). Therefore, it is possible that those who had their mobility score taken in winter, and had a high score, who then subsequently had a mobility score undertaken in summer, and found a reduction in their lameness, that this reduction is due to seasonal variation, rather than as a direct result of the Health Livestock scheme. However the reverse could potentially be seen in farms that were initially scored in summer, but then subsequently scored in winter.

Secondly, although independent variables were investigated, the way in which the raw data was collected, was prohibitive of drawing significant conclusions for a couple of variables. For example, there is no explanation on the FIQ about the differences between 'standard' and 'intensive' farming systems. This means it is open to interpretation by the farmer, and what one farmer may class as 'standard', another may class as 'intensive'. Again, the number of FTEs employed on farm may be irrelevant, as farm staff could have no interactions with the cattle, their care, or management. In future, when analysing this information, a better indicator would be the herd size to FTE stockpersons ratio.

In theory, the greater number of stockpersons per cow, the higher the welfare, or the greater the potential is to implement positive change.

### **Intra-observer reliability**

Despite advising the use of the same mobility scorer for both the pre and post-intervention mobility score, on many occasions it was undertaken by two different individuals. This increases the risk of observer bias and therefore the results may not be as accurate as they could be. This was most likely due to the time constraints of veterinarians or para-professionals. To negate this in future, if there are sufficient funds, Healthy Livestock trained mobility scorers could undertake all mobility scores. Not only will this ensure that the same mobility score undertakes both scores, but the time period between scores could be more accurately imposed.

### **Research Recommendations**

Further study could include investigating which stage, or combination of stages of the Healthy Livestock lameness strand had the most significant impact upon lameness reduction. This would be valuable, as particular stages may or may not have more of an impact upon lameness prevalence than others. This information could be useful for the agricultural industry, and policy makers in order to shape future health intervention provision. Stages which had little or no benefit could be dropped from future schemes in favour of more beneficial stages. There would also be significant value in undertaking cost analysis, to determine which monetary investment in training, brought about the largest reduction in lameness. Again, this is valuable when shaping future training provision.



Due to the significant size of the data gathered, there were some aspects that were unable to be analysed due to time constraints. Seasonal variations, observer variations and the trend in lameness prevalence over the duration of the Healthy Livestock Scheme would all contribute to the scientific and agricultural community.

## **Chapter Eight**

### **Conclusion**

Engaging farmers to progress along a successful route to healthier cattle has been a challenge in the past (Bell et al., 2009; Leach et al., 2010b). The successes of health intervention schemes have varied, but the reasons why they have or have not been successful were noted in the formation of the Healthy Livestock Scheme.

The overall impact on lameness prevalence for farmers participating in the Healthy Livestock scheme has been significant. A move from one in every four cows being lame, to one in every 5 cows represents a 23% reduction in lameness. Not only is this extremely positive in terms of improving animal welfare, but it also provides significant cost savings to the farmer.

Further to this, the Healthy Livestock scheme proved valuable to all types of farms, as none of the independent variables had an effect upon the amount of change seen. The next area of study that would be hugely beneficial for the industry, would be the cost – benefit analysis, to determine which stage or type of training provided the most beneficial in terms of reducing lameness.

## References

AHDB (2016). Lameness. [ONLINE] <http://dairy.ahdb.org.uk/technical-information/animal-health-welfare/lameness/> Accessed: 25.04.16

AHDB Dairy (2015). Average Herd Size. [ONLINE] <http://dairy.ahdb.org.uk/resources-library/market-information/farming-data/average-herd-size/#.VyHkYHn2bIV> Accessed 10.11.15

Amory, J.R., Barker, Z.E., Wright, J.L., Mason, S.A., Blowey, R.W., and Green, L.E. (2008). Associations between sole ulcer, white line disease and digital dermatitis and the milk yield of 1824 dairy cows on 30 dairy cow farms in England and Wales from February 2003–November 2004. *Prev. Vet. Med.* *83*, 381–391.

Andreasen, S.N., and Forkman, B. (2012). The welfare of dairy cows is improved in relation to cleanliness and integument alterations on the hocks and lameness when sand is used as stall surface. *J. Dairy Sci.* *95*, 4961–4967.

Archer, S.C., Green, M.J., and Huxley, J.N. (2010). Association between milk yield and serial locomotion score assessments in UK dairy cows. *J. Dairy Sci.* *93*, 4045–4053.

Archer, S.C., Newsome, R., Dibble, H., Sturrock, C.J., Chagunda, M.G.G., Mason, C.S., and Huxley, J.N. (2015). Claw length recommendations for dairy cow foot trimming. *Vet. Rec.* *177*, 222.

Barker, Z.E., Leach, K.A., Whay, H.R., Bell, N.J., and Main, D.C.J. (2010). Assessment of lameness prevalence and associated risk factors in dairy herds in England and Wales. *J. Dairy Sci.* *93*, 932–941.

Bell, N.J. (2005). Lameness: Evaluation, hazards and interventions. *Cattle Pract.* *13*, 103–112.

Bell, N.J., Bell, M.J., Knowles, T.G., Whay, H.R., Main, D.J., and Webster, A.J.F. (2009). The development, implementation and testing of a lameness control programme based on HACCP principles and designed for heifers on dairy farms. *Vet. J.* *180*, 178–188.

Benn, H. (2009). House of Commons Environment, Food and Rural Affairs Committee Securing Food Supplies up to 2050: The Challenges Faced by the UK. (The House of Commons).

Bennett, R., and Cooke, R. (2005). Control of bovine TB: preferences of farmers who have suffered a TB breakdown. *Vet. Rec.* *156*, 143–145.

Bicalho, R.C., Machado, V.S., and Caixeta, L.S. (2009). Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. *J. Dairy Sci.* *92*, 3175–3184.

Binkmann, J., and Winckler, C. (2004). Influence of the housing system on lameness prevalence in organic dairy farming. In Proceedings 13th International Symposium, (Maribor, Slovenia), pp. 166–167.

Blood, D.C., Studdert, V.P., and Gay, C.C. (2006). Saunders Comprehensive Veterinary Dictionary. (Saunders Ltd),.

Blowey, R. (2005). Factors associated with lameness in dairy cattle. In *Pract.* 27, 154–162.

Boettcher, P.J., Dekkers, J.C.M., Warnick, L.D., and Wells, S.J. (1998). Genetic Analysis of Clinical Lameness in Dairy Cattle. *J. Dairy Sci.* 81, 1148–1156.

Booth, C.J., Warnick, L.D., Gröhn, Y.T., Maizon, D.O., Guard, C.L., and Janssen, D. (2004). Effect of Lameness on Culling in Dairy Cows. *J. Dairy Sci.* 87, 4115–4122.

Candel, J.J.L., Breeman, G.E., Stiller, S.J., and Termeer, C.J.A.M. (2014). Disentangling the consensus frame of food security: The case of the EU Common Agricultural Policy reform debate. *Food Policy* 44, 47–58.

Central Intelligence Agency (2014). The World Factbook. [ONLINE] <https://www.cia.gov/library/publications/the-world-factbook/index.html> Accessed; 19.11.14

Chaplin, S.J., Ternent, H.E., Offer, J.E., Logue, D.N., and Knight, C.H. (2000). A comparison of hoof lesions and behaviour in pregnant and early lactation heifers at housing. *Vet. J. Lond. Engl.* 1997 159, 147–153.

Chen, J., Huang, P., McCarl, B.A., and Shiva, L. (2014). Climate Change, Society, and Agriculture: An Economic and Policy Perspective. In *Encyclopedia of Agriculture and Food Systems*, (Elsevier), pp. 294–306.

Chesterton, R.N., Pfeiffer, D.U., Morris, R.S., and Tanner, C.M. (1989). Environmental and behavioural factors affecting the prevalence of foot lameness in New Zealand dairy herds - a case-control study. *N. Z. Vet. J.* 37, 135–142.

Cook, N.B. (2003a). Prevalence of lameness among dairy cattle in Wisconsin as a function of housing type and stall surface. *J. Am. Vet. Med. Assoc.* 223, 1324–1328.

Cook, N.B. (2003b). Prevalence of lameness among dairy cattle in Wisconsin as a function of housing type and stall surface. *J. Am. Vet. Med. Assoc.* 223, 1324–1328.

Cook, N.B., and Nordlund, K.V. (2009). The influence of the environment on dairy cow behavior, claw health and herd lameness dynamics. *Vet. J.* 179, 360–369.

DEFRA (2009). UK Food Security Assessment: Detailed Analysis.

DEFRA (2013). Agriculture in the United Kingdom 2013. Pocket book.

DEFRA (2014). Farming Statistics - Livestock Populations at 1 December 2013, United Kingdom.

DeFrain, J.M., Socha, M.T., and Tomlinson, D.J. (2013). Analysis of foot health records from 17 confinement dairies. *J. Dairy Sci.* 96, 7329–7339.

Dippel, S., Dolezal, M., Brenninkmeyer, C., Brinkmann, J., March, S., Knierim, U., and Winckler, C. (2009). Risk factors for lameness in cubicle housed Austrian Simmental dairy cows. *Prev. Vet. Med.* 90, 102–112.

Dobson, H., Walker, S.L., Morris, M.J., Routly, J.E., and Smith, R.F. (2008). Why is it getting more difficult to successfully artificially inseminate dairy cows? *Animal* 2.

Elliott, S., and Benson, N. (2012). *Wartime Farm* (BBC).

Enevoldsen, C., Gröhn, Y.T., and Thysen, I. (1991). Sole Ulcers in Dairy Cattle: Associations with Season, Cow Characteristics, Disease, and Production. *J. Dairy Sci.* 74, 1284–1298.

Enting, H., Kooij, D., Dijkhuizen, A.A., Huirne, R.B.M., and Noordhuizen-Stassen, E.N. (1997). Economic losses due to clinical lameness in dairy cattle. *Livest. Prod. Sci.* 49, 259–267.

Esslemont, R.J., and Kossaibati, M.A. (1996). Incidence of production diseases and other health problems in a group of dairy herds in England. *Vet. Rec.* 139, 486–490.

FAO (2009). How to Feed the World in 2050.[ONLINE]  
[http://www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf) Accessed; 06.06.14

Field, C.B., Barros, V.B., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K., Estrada, Y., Genova, R.C., et al. (2014). IPCC, 2014: Summary for policymakers. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

Galindo, F., and Broom, D.M. (2000). The relationships between social behaviour of dairy cows and the occurrence of lameness in three herds. *Res. Vet. Sci.* 69, 75–79.

Green, L.E., Hedges, V.J., Schukken, Y.H., Blowey, R.W., and Packington, A.J. (2002). The Impact of Clinical Lameness on the Milk Yield of Dairy Cows. *J. Dairy Sci.* 85, 2250–2256.

Green, L.E., Huxley, J.N., Banks, C., and Green, M.J. (2014). Temporal associations between low body condition, lameness and milk yield in a UK dairy herd. *Prev. Vet. Med.* 113, 63–71.

Gregory, N., Craggs, L., Hobson, N., and Krogh, C. (2006). Softening of cattle hoof soles and swelling of heel horn by environmental agents. *Food Chem. Toxicol.* 44, 1223–1227.

- Harvey, D., and Riley, M. (2009). "Fighting from the fields": developing the British "National Farm" in the Second World War. *J. Hist. Geogr.* 35, 495–516.
- Haskell, M.J., Rennie, L.J., Bowell, V.A., Bell, M.J., and Lawrence, A.B. (2006). Housing System, Milk Production, and Zero-Grazing Effects on Lameness and Leg Injury in Dairy Cows. *J. Dairy Sci.* 89, 4259–4266.
- Hernandez, J., Shearer, J.K., and Webb, D.W. (2001). Effect of lameness on the calving-to-conception interval in dairy cows. *J. Am. Vet. Med. Assoc.* 218, 1611–1614.
- Hernandez, J.A., Garbarino, E.J., Shearer, J.K., Risco, C.A., and Thatcher, W.W. (2005). Comparison of the calving-to-conception interval in dairy cows with different degrees of lameness during the prebreeding postpartum period. *J. Am. Vet. Med. Assoc.* 227, 1284–1291.
- Hobler, K., Weiss, W., Smilie, R., and Midla, L. (2000). Subclinical laminitis in dairy cattle: Maintaining healthy hoof horns. 22, s97–s107, s115.
- Huang, Y.C., Shanks, R.D., and McCoy, G.C. (1995). Evaluation of fixed factors affecting hoof health. *Livest. Prod. Sci.* 44, 115–124.
- Huxley, J.N., Burke, J., Roderick, S., Main, D.C.J., and Whay, H.R. (2004). Animal welfare assessment benchmarking as a tool for health and welfare planning in organic dairy herds. *Vet. Rec.* 155, 237–239.
- Kinealy, C. (1994). *This great calamity: the Irish famine, 1845-52* (Dublin: Gill & Macmillan).
- Klitgaard, K., Nielsen, M.W., Ingerslev, H.-C., Boye, M., and Jensen, T.K. (2014). Discovery of bovine digital dermatitis-associated *Treponema* spp. in the dairy herd environment by a targeted deep-sequencing approach. *Appl. Environ. Microbiol.* 80, 4427–4432.
- Laven, R.A., and Hunt, H. (2002). Evaluation of copper sulphate, formalin and peracetic acid in footbaths for the treatment of digital dermatitis in cattle. *Vet. Rec.* 151, 144–146.
- Laven, R.A., and Logue, D.N. (2006). Treatment strategies for digital dermatitis for the UK. *Vet. J. Lond. Engl.* 1997 171, 79–88.
- Leach, K.A., Whay, H.R., Maggs, C.M., Barker, Z.E., Paul, E.S., Bell, A.K., and Main, D.C.J. (2010a). Working towards a reduction in cattle lameness: 2. Understanding dairy farmers' motivations. *Res. Vet. Sci.* 89, 318–323.
- Leach, K.A., Whay, H.R., Maggs, C.M., Barker, Z.E., Paul, E.S., Bell, A.K., and Main, D.C.J. (2010b). Working towards a reduction in cattle lameness: 1. Understanding barriers to lameness control on dairy farms. *Res. Vet. Sci.* 89, 311–317.
- Lim, P.Y., Huxley, J.N., Willshire, J.A., Green, M.J., Othman, A.R., and Kaler, J. (2015). Unravelling the temporal association between lameness and body condition score in dairy cattle using a multistate modelling approach. *Prev. Vet. Med.* 118, 370–377.

Liu, Y.S., Wang, J.Y., and Long, H.L. (2010). Analysis of arable land loss and its impact on rural sustainability in Southern Jiangsu Province of China. *J. Environ. Manage.* *91*, 646–653.

Logue, D.N., Offer, J.E., Laven, R.A., and Ellis, W.A. (2005). Digital dermatitis – The aetiological soup. *Vet. J.* *170*, 12–13.

Losinger, W.C. (2006). Economic impacts of reduced milk production associated with papillomatous digital dermatitis in dairy cows in the USA. *J. Dairy Res.* *73*, 244–256.

Main, D.C.J., Leach, K.A., Barker, Z.E., Sedgwick, A.K., Maggs, C.M., Bell, N.J., and Whay, H.R. (2012). Evaluating an intervention to reduce lameness in dairy cattle. *J. Dairy Sci.* *95*, 2946–2954.

Manske, T., Hultgren, J., and Bergsten, C. (2002). Prevalence and interrelationships of hoof lesions and lameness in Swedish dairy cows. *Prev. Vet. Med.* *54*, 247–263.

Met Office (2013). *Climate Summaries*.

Meyer, C., Matzdorf, B., Müller, K., and Schleyer, C. (2014). Cross Compliance as payment for public goods? Understanding EU and US agricultural policies. *Ecol. Econ.* *107*, 185–194.

Murray, R.D., Downham, D.Y., Clarkson, M.J., Faull, W.B., Hughes, J.W., Manson, F.J., Merritt, J.B., Russell, W.B., Sutherst, J.E., and Ward, W.R. (1996). Epidemiology of lameness in dairy cattle: description and analysis of foot lesions. *Vet. Rec.* *138*, 586–591.

NADIS (2016). Lameness Control in Dairy Herds. Part 5. Digital Dermatitis. [ONLINE] <http://www.nadis.org.uk/bulletins/lameness-control-in-dairy-herds/part-5-digital-dermatitis-causes-treatment-and-control.aspx> Accessed: 16.03.16

Navarro, G., Green, L.E., and Tadich, N. (2013). Effect of lameness and lesion specific causes of lameness on time budgets of dairy cows at pasture and when housed. *Vet. J. Lond. Engl.* *197*, 788–793.

Van Nuffel, A., Van De Gucht, T., Saeys, W., Sonck, B., Opsomer, G., Vangeyte, J., Mertens, K.C., De Ketelaere, B., and Van Weyenberg, S. (2015). Environmental and cow-related factors affect cow locomotion and can cause misclassification in lameness detection systems. *Anim. Int. J. Anim. Biosci.* 1–9.

Presi, P., Struchen, R., Knight-Jones, T., Scholl, S., and Heim, D. (2011). Bovine viral diarrhoea (BVD) eradication in Switzerland—Experiences of the first two years. *Prev. Vet. Med.* *99*, 112–121.

Randall, L.V., Green, M.J., Chagunda, M.G.G., Mason, C., Archer, S.C., Green, L.E., and Huxley, J.N. (2015). Low body condition predisposes cattle to lameness: An 8-year study of one dairy herd. *J. Dairy Sci.* *98*, 3766–3777.

- Reader, J.D., Green, M.J., Kaler, J., Mason, S.A., and Green, L.E. (2011). Effect of mobility score on milk yield and activity in dairy cattle. *J. Dairy Sci.* *94*, 5045–5052.
- Rodriguez-Lainz, A., Melendez-Retamal, P., Hird, D.W., Read, D.H., and Walker, R.L. (1999). Farm- and host-level risk factors for papillomatous digital dermatitis in Chilean dairy cattle. *Prev. Vet. Med.* *42*, 87–97.
- Ross, D. (2002). *Ireland: history of a nation* (New Lanark: Geddes & Grosset).
- Rowlands, G.J., Russell, A.M., and Williams, L.A. (1983). Effects of season, herd size, management system and veterinary practice on the lameness incidence in dairy cattle. *Vet. Rec.* *113*, 441–445.
- Rowlands, G.J., Russell, A.M., and Williams, L.A. (1985). Effects of stage of lactation, month, age, origin and heart girth on lameness in dairy cattle. *Vet. Rec.* *117*, 576–580.
- Shepherd, F., and Reigate, C. (2015). *Cattle Lameness*. [ONLINE] [www.farmhealthonline.org.uk](http://www.farmhealthonline.org.uk)
- Shepherd, F., Whitaker, T., and Ward, P. (2012). A preliminary study investigating factors affecting percentage of lameness in dairy cattle on farms in the south west of England. In *Advances in Animal Biosciences*, (Nottingham: Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), p. 183.
- Sogstad, Å.M., Fjeldaas, T., and Østerås, O. (2011). Association of claw disorders with claw horn colour in norwegian red cattle - a cross-sectional study of 2607 cows from 112 herds. *Acta Vet. Scand.* *53*, 59.
- Somers, J.G.C.J., Frankena, K., Noordhuizen-Stassen, E.N., and Metz, J.H.M. (2005). Risk factors for digital dermatitis in dairy cows kept in cubicle houses in The Netherlands. *Prev. Vet. Med.* *71*, 11–21.
- Sullivan, L.E., Blowey, R.W., Carter, S.D., Duncan, J.S., Grove-White, D.H., Page, P., Iveson, T., Angell, J.W., and Evans, N.J. (2014). Presence of digital dermatitis treponemes on cattle and sheep hoof trimming equipment. *Vet. Rec.* *175*, 201–201.
- Synge, B., Clark, A., Moar, J.A., Nicolson, J., Nettleton, P., and Herring, J. (1999). The control of bovine virus diarrhoea virus in Shetland. *Vet. Microbiol.* *64*, 223–229.
- Tarlton, J.F., Holah, D.E., Evans, K.M., Jones, S., Pearson, G.R., and Webster, A.J.F. (2002). Biomechanical and histopathological changes in the support structures of bovine hooves around the time of first calving. *Vet. J. Lond. Engl.* *1997* *163*, 196–204.
- Teixeira, A.G.V., Machado, V.S., Caixeta, L.S., Pereira, R.V., and Bicalho, R.C. (2010). Efficacy of formalin, copper sulfate, and a commercial footbath product in the control of digital dermatitis. *J. Dairy Sci.* *93*, 3628–3634.
- United Nations (2004). *World Population to 2300*.



Vaarst, M., Hindhede, J., and Enevoldsen, C. (1998). Sole disorders in conventionally managed and organic dairy herds using different housing systems. *J. Dairy Res.* 65, 175–186.

War Agricultural Committee (1939). War Agricultural Committee. *Nature* 144, 473–473.

Ward (1999). Lameness in Dairy Cattle - An Overview. *Cattle Pract.* 7, 333–340.

Webster, J. (2005). *Animal welfare: limping towards Eden ; a practical approach to redressing the problem of our dominion over the animals* (Oxford: Blackwell Pub).

Whay, H. (2002). Locomotion scoring and lameness detection in dairy cattle. *In Pract.* 24, 444–449.

Whay, H.R., Waterman, A.E., and Webster, A.J.F. (1997). Associations between locomotion, claw lesions and nociceptive threshold in dairy heifers during the peri-partum period. *Vet. J.* 154, 155–161.

Whay, H.R., Barker, Z.E., Leach, K.A., and Main, D.C.J. (2012). Promoting farmer engagement and activity in the control of dairy cattle lameness. *Vet. J.* 193, 617–621.

Whitaker, D.A., Kelly, J.M., and Smith, E.J. (1983). Incidence of lameness in dairy cows. *Vet. Rec.* 113, 60–62.




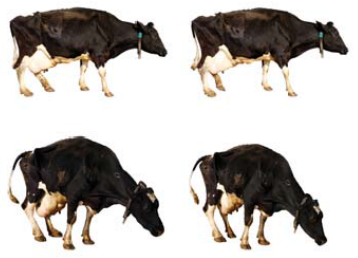
Whitaker, D.A., Macrae, A.I., and Burrough, E. (2004). Disposal and disease rates in British dairy herds between April 1998 and March 2002. *Vet. Rec.* 155, 43–47.

Wood, S., Lin, Y., Knowles, T.G., and Main, D.C.J. (2015). Infrared thermometry for lesion monitoring in cattle lameness. *Vet. Rec.* 176, 308.

## **Appendices**

**Appendix A. Dairy Co Mobility Score Guide**

# DairyCo Mobility Score

Category of score	Score	Description of cow behaviour	Suggested action
<p><b>Good mobility</b></p> 	0	<p>Walks with even weight bearing and rhythm on all four feet, with a flat back.</p> <p>Long, fluid strides possible.</p>	<ul style="list-style-type: none"> <li>No action needed.</li> <li>Routine (preventative) foot trimming when/if required.</li> <li>Record mobility at next scoring session.</li> </ul>
<p><b>Imperfect mobility</b></p> 	1	<p>Steps uneven (rhythm or weight bearing) or strides shortened; affected limbs or limbs not immediately identifiable.</p>	<ul style="list-style-type: none"> <li>Could benefit from routine (preventative) foot trimming when/if required.</li> <li>Further observation recommended.</li> </ul>
<p><b>Impaired mobility</b></p> 	2	<p>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).</p>	<ul style="list-style-type: none"> <li>Lame and likely to benefit from treatment.</li> <li>Foot should be lifted to establish the cause of lameness before treatment.</li> <li>Should be attended to as soon as practically possible.</li> </ul>
<p><b>Severely impaired mobility</b></p> 	3	<p>Unable to walk as fast as a brisk human pace (cannot keep up with the healthy herd) and signs of score 2.</p>	<ul style="list-style-type: none"> <li>Very lame.</li> <li>Cow will benefit from treatment.</li> <li>Cow requires urgent attention, nursing and further professional advice.</li> <li>Cow should not be made to walk far and kept on a straw yard or at grass.</li> <li>In the most severe cases, culling may be the only possible solution.</li> </ul>

# D.

## How to score your herd

If you haven't scored your herd for a while, information and video clips can be viewed on the DairyCo website at [www.dairyco.org.uk](http://www.dairyco.org.uk). Visit the farm management section and click on What's New and Business Tools.

In general:

1. Check your herd ideally at least once a month.
2. Choose a time and a place which will allow you to observe cows ideally on a hard (ie concrete) non-slip surface. Monitor each cow individually allowing them to make between 6-10 uninterrupted strides. Watch the cows from the side and the rear, and if possible ensure the cow turns a corner as part of her test.
3. Record the identities of cows scoring 2 or 3 and schedule treatment with regular checks to ensure treatment is working.
4. Keep a tally of cows that are score 0 and 1.
5. If you are uncertain about the exact score of a cow, make repeat observations. If you are still unsure, examine her feet.

## Key benefits of scoring

1. Every cow is regularly assessed for the early signs of poor mobility prompting foot trimming and action lists.
2. Mobility trends can be monitored to identify new problems at an early stage.
3. Provision of figures for benchmarking performance.
4. General foot health awareness is increased.
5. Motivates farm staff to improve herd mobility and therefore overall herd health.

For further information on using the mobility score contact the extension officer team at DairyCo on 01285 646500.

## **Appendix B. Healthy Livestock Lameness Strand Guide**

### **Guidance for Deliverers: Lameness in Dairy Cattle**

As a vet, your role within the Healthy Livestock project will be to develop an effective training programme through your vet practice, for farmers who want to improve lameness in their herd. This will involve assessing the level of lameness on their farm and directing them to the relevant workshops and discussion groups, which may be coordinated and run by you or an external lameness adviser. The combination of formal training, mentoring and farmer group meetings is likely to represent the most cost-effective approach to improving foot health in the south west.

#### **Become an approved trainer:**

The training that your vet practice provides will need to be approved by the Healthy Livestock project so that consistent training is provided by all the vet practices in the south west and which also meets funding requirements.

As we link up the Healthy Livestock lameness strand with DairyCo's Healthy Feet programme, both of which are based on the Bristol University's Healthy Feet project, we will not be running any more deliverer information events for lameness. Instead, if you wish to deliver under Healthy Livestock, and you have not yet attended a Healthy Livestock Lameness Deliverer Information Event, you will need to attend the DairyCo Healthy Feet Programme training to become a mobility mentor. Please contact Kate Cross at DairyCo for information on the next DairyCo Healthy Feet Programme training dates.

### **The Process**

#### **Lameness 1 - Lameness Awareness**

In order to recruit farmers onto the lameness strand, and to discuss the causes and treatments of lameness, you may wish to hold a lameness awareness meeting. Unlike the Johne's or BVD strands of Healthy Livestock, the Lameness Awareness meeting is **not compulsory**.

#### **Lameness 2 - Initial Mobility Score (1hr)**

Mobility scoring will need to be carried out on each participating farm, to assess the initial level of lameness.

#### **Lameness 3 - Lift Feet, Review Records (2hrs)**

On this visit, the aim is to determine the predominant lesion type in the herd. To do this, randomly select a number of cows in the herd, and pick up their feet to assess hoof health and lesion type. While on farm, ask to see the farmer's lameness records. These should be reviewed to understand what the predominant lesions have been on farm. **Due to the nature of the work, this should be carried out by veterinarians only.**

#### **Lameness 4 - Risk Checklist (1hr)**

A lameness risk assessment of the farm would be required to find out where the risks for lameness might be and in particular at the risks during herding and milking.

**Due to the nature of the work, this should be carried out by veterinarians only.**

### **Lameness 5 - Facilitated Workshop (1.5hrs)**

Engage the whole farm team who might influence lameness, including the person who has budgetary control, and those who have day to day contact with the cows. Discuss the various lameness issues specific to the farm and discuss ways in which the team can reduce lameness, and how this will be implemented. From this workshop, develop an action plan with the farmer, specific to the farm to encourage changes to be made to reduce lameness in the herd. **Due to the nature of the work, this should be carried out by veterinarians only.**

### **Lameness 6 - Two Day Foot Trimming Course (14hrs)**

A practical skills based training course can be offered that will focus on foot trimming using the Dutch 5 Step method. This will provide an introduction to lameness prevention to supply the foundation necessary to implement the concepts covered in the next stages of the programme. A list of approved Category one foot-trimming trainers is available in the 'Training Resources' area within the secure deliverers pages of the Healthy Livestock website.

### **Lameness 7 - One of 4 workshops (3hrs)**

Farmers will be advised to attend workshops dependent on the risks present on farm and the predominant lesion type in the herd. This will encourage farmers to share practical ideas on how to deal with the diagnosed problems with some expert input.

**Digital Dermatitis** - Hygiene and foot bathing

**Sole Ulcer** - Cow comfort and standing time

**White Line** - Tracks and cow flow

**Severely lame cows** - Prompt treatment and mobility scoring.




### **Lameness 8 - Visit to local focus farm (2hrs)**

The focus farm will be one that has commendable levels of foot health and high standards of lameness management. The aim of this is to provide an opportunity for learning, through best-practice methods which have been tried, tested and proven to work.

### **Lameness 9 - Final Mobility Score (1hr)**

Twelve months after you have undertaken the initial mobility score, we require a second and final mobility score in order to demonstrate improvement.



Healthy Livestock Stage	DairyCo HFP compatible	Event Type	Task	Time allocated (hrs)	Cost (pp)	30% Private Sector
Lameness 1		Group	Lameness Awareness Meeting			
Lameness 2	 Mobility Score	1:1	Initial Mobility Score	1	£100	£30
Lameness 3	 Visit 1	1:1	Lift Feet, Review Records	2	£200	£60
Lameness 4	 Visit 2	1:1	Risk Checklist	1	£100	£30
Lameness 5	 Visit 3	1:1	Facilitated Workshop & Action Plan	1.5	£150	£45
Lameness 6		Group	Two Day Foot Trimming Course	14		£90
Lameness 7		Group	One of 4 workshops	3		
Lameness 8		Group	Visit to local focus farm	2		
Lameness 9	 Mobility Score	1:1	Final Mobility Score	1	£100	£30

If you are a registered DairyCo Mobility Mentor, you are eligible to deliver the Healthy Livestock Lameness strand of the project. If you would like to deliver the DairyCo Healthy Feet Programme, Healthy Livestock funding is available for some aspects.

Please see the table above to determine which aspects of the DairyCo Healthy Feet Programme can be claimed for under Healthy Livestock. To carry out funded Healthy Feet Programme training, submit an EDF in the same way you would for the Healthy Livestock funding. e.g. at least seven days prior to your first DCHFP visit, submit an EDF for Lameness 3, and carry out the HFP Visit 1 as you would normally under DairyCo Healthy Feet Programme, but ensure all of the Healthy Livestock paperwork has been completed (Enrolment card, Blue Log, Farm Information Questionnaire & Mobility score).



A RDPE initiative from the Rural Business School

**Appendix C: Farm Information Questionnaire**



**Farm Information Questionnaire**

**Delegate Details:**

**Forename:** .....

**Surname:** .....

**Vet:** .....

**Adviser:** .....

**Training organisation:** .....

**Farm Details:**

**Farm Name:** .....

**Farm Size:** .....acs/ha (delete as appropriate)

**Herd Type (Please circle)**                  Dairy                  Beef                  Sheep

**Number of Adult Herd / Flock:**                                                     

**Main Breed:**                                                     

**Farming System (Please Circle):**                  Standard                  Intensive                  Organic

**Housing:**    Freestalls or Cubicles                  Straw yards                  Mixture of Freestalls and Yards

**No. of stockpersons, including family:**    Full Time                   Part Time

**Herd ear tag prefix (UK+ 6 digits)**.....

Thank you for taking the time to complete this questionnaire. Your results will help us monitor the impact of the project.



A RDPE initiative from the Rural Business School



## **Publications**

183

**A preliminary study investigating factors affecting percentage of lameness in dairy cattle on farms in the south west of England**

F. Shepherd, T Whitaker, P Ward

Rural Business School, Duchy College, Cornwall, UK Email: [tim.whitaker@duchy.ac.uk](mailto:tim.whitaker@duchy.ac.uk)

**Introduction** Lameness in dairy cattle is a considerable problem facing farmers and the wider dairy industry. Significant financial loss can be accrued through lameness; this can be observed via loss in production, as well as additional costs in health management. Various farm health planning and management strategies can be implemented to reduce loss. This study is a preliminary investigation reporting a number of descriptive farm parameters and observed levels of lameness within dairy farms across the south west region. The study is the result of initial data collection from the 'South West Healthy Livestock Initiative' a regional project designed to reduce the level and improve the management of a variety of 'on farm' livestock health and disease issues facing farmers.

**Method** The study population consisted of 102 dairy farms across the south west region. Of these, 90 farms were used within the analysis. Twelve farms returned incomplete data information and were excluded. The dependant variable tested within the analysis was the overall percentage of herd lameness. Overall herd lameness was defined by the number of animals returning lameness assessment score of two or three as a percentage of the total herd size. All lameness assessments were undertaken by veterinary surgeons using a standardised moderated scoring system. Independent variables used within the analysis were farming system, housing system and numbers of full time equivalent (FTE) stockpersons working on farm. These variables were appraised using an analysis of variance. The dependant variable, overall percentage of herd lameness was normally distributed (Pearsons skewness test 0.892) for the population. Therefore it was not deemed necessary to undertake an arcsin transformation. Further analysis was undertaken using Pearson's correlations co-efficiencies for farm size (hectares), herd size and the dependant variable overall percentage herd lameness.

**Results** The mean farm size was 173.6 ( $\pm 116.0$ )ha with a range from 33.2 ha to 606.9ha. Mean herd size was 175.6 ( $\pm 85.2$ ) with a range from 47 to 466 cows. Herd lameness for the population was returned at 26.5% ( $\pm 13.5$ ) with a range from 3.3% to 72.9%. 73% (n=66) of the farms studied used a standard farming system, 18% (n=16) extensive and 9% (n=8) organic. 70% (n=63) used a combination of freestalls and cubicles, 27% (n=24) freestalls and yards and 3% (n=3) yards only. 13% (n=12) of farms had one or less stockperson FTE's, 34% (n=31) two FTE's, 34% (n=31) three FTE's and 21% (n=19) four or more FTE's.

A significantly ( $df = 89$ ,  $F = 3.3$ ,  $P < 0.05$ ) lower level of lameness was observed on organic farms (15.6%) when compared to intensive (25.2%) and standard (28.1%) farming systems. No differences in lameness levels were observed when housing systems were considered, freestalls and cubicles 25.5%, freestalls and yards 26.7% and yards 25.6%. Higher percentage levels of lameness were observed on farms where one or less FTE's were working (30.2%) when compared with other farms within the studied population; two FTE's 24.7%, three FTE's 26.5% and four or more FTE's 27%. This relationship however was not statistically significant. There was no correlatory relationship between herd size and percentage of lameness ( $r = -0.025$ ), or farm size (ha) and percentage lameness ( $r = -0.039$ ).

**Conclusion** The results from this preliminary study indicate that farming system has a significant effect on levels of recorded lameness within dairy herds in the south west region; organic farming systems having a considerably lower incidence. The reasons for this are likely to be multi-factorial and are worthy of further study. Other factors considered within this study appeared not to be significant although it is noted that those farms with one or less FTE's do see higher (although not significant) levels of lameness. Further study is required on a larger population to investigate these and other factors that might play a role in the level of lameness observed on dairy farms.

179

**A preliminary investigation into the presence, risk of entry and risk of on-farm spread of Johne's disease in the south west of England**

F. Shepherd, T Whitaker, P Ward  
 Duchy College RBS, Callington, UK Email: paul.ward@duchy.ac.uk

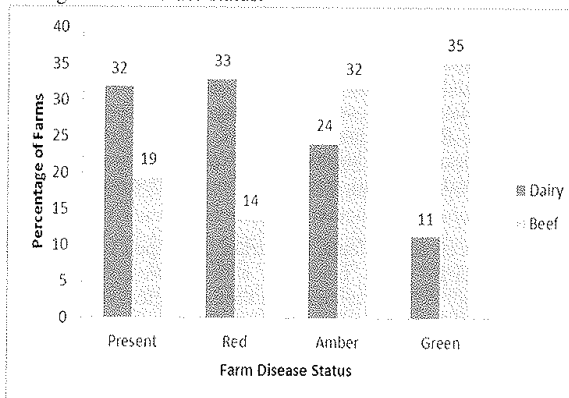
**Introduction** Johne's disease is a degenerative infectious disease affecting ruminants (primarily cattle). The disease causes significant reduction in milk yield with likely considerable financial loss through reduction in output and consequential culling. It has been suggested, though not proven or disproven that there may be a link between Johne's disease and possible causes of Crohn's Disease in humans. Any such link would have profound effects for the dairy industry and animal health policy. The study aimed to establish the level of disease as well as examining the level of control measures used to prevent farm entry and farm spread for the disease, within a defined population. This study used data collated by the RDPE-funded Healthy Livestock project led-by Duchy College's Rural Business School, a regional project designed to reduce the level and improve the management of a variety of cattle and sheep diseases. Data was collated using the on-line herd health planning tool 'Myhealthyherd'.

**Method** Data relating to Johne's Disease was collected from dairy (n=555) and beef (n=348) farms, across Cornwall (n=235), Devon (n=382), Somerset (n=130), Avon (n=30), Dorset (n=87), Gloucestershire (n=72) and Wiltshire (n=33). Data was discriminated by the farm disease status. Disease status was defined as green – no disease recorded, amber – possible disease recorded, red – confirmed recording of disease but with no active observed occurrences, and disease present – confirmed recording of disease with active observed occurrences. Additionally farm disease entry risk status, and on-farm disease spread risk status data was assessed. These two statuses were recorded via a standardised protocol established from a questionnaire and veterinary assessment. Green – effective precautions against entry or on farm spread. Amber – entry or spread protocols in place but not wholly adequate. Red inadequate entry or on farm spread protocols Data was considered by farm type (dairy or beef). Descriptive statistics for the studied population were returned. Further Chi squared analysis was undertaken on the data relating to farm disease status.

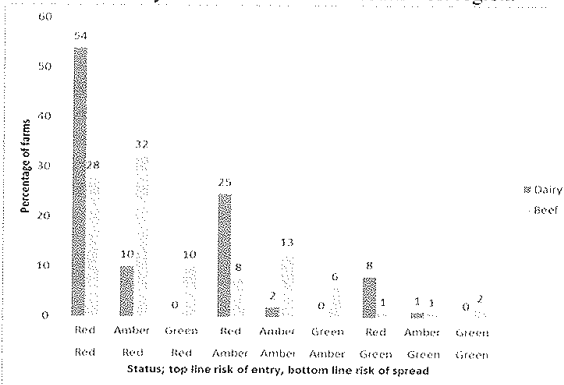
**Results** Data relating to farm disease status was collected from 37% (n=204) of dairy and 25% (n=88) of beef farms within the total population. A small number n=23 (11%) of dairy farms were free (green) of Johne's disease, with n=132, 65% either testing positive or having observed incidences (Figure 1). A reverse trend was noted on beef farms. (

P<0.001). Data relating to farm disease entry risk status, and on-farm disease spread risk status was collated from 64% (n=356) of dairy and 34% (n=118) of beef farms in the total population. Figure 2 shows the percentage distribution for risk of entry and risk of on farm spread.

**Discussion** A significant proportion of dairy farms had the presence of Johne's disease. Generally within the population the levels of risk (entry and spread) were found to be lower on beef farms. 54% of dairy farms within the studied population were defined as Red/Red in terms of risk of entry and spread of Johne's disease. When the data is analysed further 87% of dairy farms are defined as having a Red status for disease entry to farms. These figures are of significant concern and appropriate strategies need to be implemented by the farming community and associated agencies to mitigate against the risk Johne's disease possess and the consequential considerable economic loss escalation might cause. Further data collection is required to allow appropriate statistical techniques to be applied to the entry and spread data sets.



**Figure 1** Degree (measure in percentage) of Johne's disease measured on dairy and beef farms in the south west region.



**Figure 2** Risk of entry and risk of spread of Johne's disease on dairy and beef farms in the south west region.