THE COST OF LAMENESS IN IRISH DAIRY HERDS

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Lameness is a painful condition which severely compromises cow welfare (Shearer et al, 2013), reduces longevity (Booth et al, 2004), fertility (Gabarino et al, 2004), and milk production (Bicalho et al, 2008), impacts environmental sustainability (Mostert et al, 2018) and, as such, is one of the most significant health and welfare issues facing the dairy sector worldwide.

Lameness describes any deviation from the normal walking gait of an animal, and is a clinical sign of a number of different conditions, rather than a disease in itself. The vast majority of lameness in dairy cows is due to lameness involving the foot, with the lateral claw of the hind leg and the medial claw of the foreleg most commonly affected due to the importance of these as the primary weight-bearing claws.

Foot disorders can be divided into two main categories: non-infectious (including white line disease, solar haemorrhages and sole ulcers) and infectious diseases (including digital dermatitis, foul in the foot and interdigital dermatitis). The most common lesions causing lameness on Irish dairy farms are non-infectious (Browne et al, 2022; Logan et al, 2023).

Estimated prevalences of lameness vary widely, but in general are lower for pasture-based systems and higher for indoor systems. Estimates range from as low as 3.8 per cent in year-round, pasture-based systems (Beggs et al, 2019) to 63 per cent in fully-housed systems (von Keyserlingk et al, 2012). Recent Irish research showed that the average prevalence of lameness on Irish dairy farms was nine per cent (Browne et al, 2022). However, all Irish studies have shown considerable inter-herd variation (Logan et al. 2023; Browne et al, 2022). In a study by Somers et al (2015), the average prevalence of lameness based on locomotion scoring in 10 Irish dairy herds varied from 11.6 per cent prior to breeding, to 14.6 per cent during the breeding period, to 11.6 per cent during the post-breeding period. However, 22.9 per cent of cows were identified as lame at least once during the course of the study.

This reinforces the importance of ongoing monitoring of lameness on farms and the lack of sensitivity of individual once-off prevalence estimates. Although the average lameness prevalence figure of nine per cent, found by Browne et al (2022), compares favourably to other countries, this nonetheless represents a significant source of economic loss as well as a welfare challenge in the herd. A lameness prevalence above 10 per cent is considered the threshold above which intervention is needed (EFSA, 2009), but even in herds with a lameness prevalence close to this threshold, up to 25 per cent of cows will have one lameness event per year. A recent study investigating welfare in Irish herds (Crossley et al, 2021) showed that the best performing farms had fewer than five per cent lame cows in their herds, indicating that a low level of lameness is achievable within a pasture-based system.

The economic costs of lameness are significant; lameness is estimated to be the third most costly health issue of dairy cows after mastitis and fertility (Bruijnis et al, 2010). The costs arise both directly and indirectly; direct costs include additional expenditure that is directly linked to the case of lameness (such as additional farm labour, cost of hoof trimming and veterinary treatment, decreased milk production, and the cost of milk withdrawal if milk has to be discarded owing to drug treatments), while indirect costs arise due to the side effects of lameness. These include reduced reproductive performance and early culling. The greatest costs related to the disease are generally losses in production, such as reproductive performance and milk yield (Willshire and Bell, 2009), but these costs may the ones of which farmers are the least aware, as they do not have to pay directly for them at the time.

In addition to the economic cost, lameness presents a huge welfare cost to cows themselves, as it causes discomfort and pain, and negatively affects the cows' normal feeding, lying and other behaviours (Whay et al, 2005). Lameness also has environmental costs because lame animals are less productive, therefore emissions per kg of milk are increased (Mostert et al, 2018; Chen et al, 2016). However, this article will focus on the economic cost alone; below, we discuss the effects that lameness has on the key drivers of farm profitability.

Lameness and milk yield

Numerous studies have shown that lameness lowers the milk yield of dairy cows. This happens for a number of reasons:

Figure 1: Sole ulcer.

1) lame cows are in pain, and as a result prefer to spend more time lying down to take weight off the painful limb, at the expense of eating (Sogstad et al, 2007; Miguel-Pacheco et al, 2014), and 2) an increased level of cortisol (released as a stress response to pain) can negatively affect rumen function.

The reduction in milk production caused by lameness varies depending on a number of factors. The point in the lactation at which it occurs is critical; if the lameness occurs once peak lactation has passed, the effects on total milk production over the course of the lactation will be less than if the lameness episode occurs before peak production. Parity also has an impact; higher parity cows have a greater milk yield and greater reduction in yield as a result. The production potential of the cow is also important; recent research has clearly demonstrated that it is the higher-yielding cows that are at greatest risk of becoming lame (Amory et al, 2008; Bicahlo et al, 2008; Green et al, 2002).

Direct Costs:	Unit	Cost / Unit (€)	Total (€)
Cost of treatments (trim; shoe; NSAIDs)			43.00
Call out fee (Vet or Trimmer)			60.00
Vet time (Min) @ €102.35/hr	20	102.35	34.12
Cost of herdsman's time (Min) @ €15/hr	40	15.00	10.00
Cost of reduced milk yield [a]			
Lower yield (litre)	360		
Net margin per litre of milk (€ /litre)		0.25	90.00
Indirect Costs:			
Cost of increased culling			
Percentage increase in culling risk [b]	28		
Cost of culling a cow [c]		600.00	168.00
Cost of longer calving interval			
Number of extra days [d]	30		
Cost of an extra day		3.50	105.00
Cost of extra services			
Number of extra services [e]	1.2		
Cost of service (€/straw)		22.00	26.40
Total Cost of a Case of Sole Ulcer			€536.52

a. Milk yield loss with sole ulcer = 6 per cent reduction in annual milk yield for a MS 3 cow (O'Connor et al, 2023) from a herd with an average herd 305 day yield of 6000L (average annual milk yield of dairy cow in Ireland).
b. Culling risk of 28 per cent taken from O'Connor et al. (2023) for MS 3.
c. Calculated as: Return from cull sale – (cost of replacement heifer + lower margin from heifer + lower value of smaller calf from heifer), based on current market figures as of February 2024.
d. Taken from: Esslemont, R. J., Kossaibati, M. (2002). "The cost of poor fertility and disease in UK dairy herds." Daisy research report No.5.
e. Taken from: Huxley J 2013. Impact of lameness and claw lesions in cows on health and production. Livestock Science 156, 64–70.

Table 1: Cost of sole ulcer.

Figure 2: White line disease (WLD).

Therefore, there is a tendency for the milk production of high-yielding cows in the herd to return to average, rather than average-yielding cows to become low-yielding. Other important factors include the severity of the lesion (lesions of greater severity will produce a greater reduction in yield), and how early the lameness is identified and treated. Many studies report milk losses occurring up to five months after the diagnosis of lameness (Green et al, 2002), while more recent research has shown that yields can drop as much as three months prior to diagnosis (Amory et al, 2008; Green et al, 2010). Identifying lameness earlier means the lesion will be at a less severe stage when treatment is instigated; cows will recover from lameness more quickly (Leach et al, 2012), and milk production losses can be minimised.

The reduction in milk production caused by lameness reported by various studies is difficult to compare for a number of reasons, including: varying definitions of lameness, different methodologies used for the analysis, and different methods of presenting data (some studies report lost production per day, while others report total losses over the entire lactation). Furthermore, studies have been conducted in many different types of cows with varying levels of baseline yields. Some studies have quantified the effect of lameness in general (not related to a specific condition), some have examined the effects relating to specific foot disorders, while others have examined the effect of different severities of lameness on milk yield. Considering studies that have reported milk losses over an entire lactation, losses range from 270kg and 574kg (Huxley, 2013). In an Irish study by O'Connor et al (2023), significant milk yield losses of up to 1.6 per cent of the average yield were associated with mobility score (MS)2 (on a 0-3 scale, with 0 representing normal mobility and 3 representing severely impaired mobility; AHDB 2013), and yield losses of up to six per cent were associated with MS3.

Lameness and reproductive performance

It is also well-established that lameness negatively affects reproductive performance. Lame cows have reduced fertility for a number of reasons. The pain associated with lameness significantly alters their behaviour and they show less signs of oestrus, making it more difficult for the farmer to detect them in heat. Lame cows have increased inflammatory

Figure 3: **Mortellaro's Digital Dermatitis.**

and stress indicators, which alters the functioning of the hypothalamus–pituitary–ovarian axis. They also eat less (González et al, 2008), and have longer and deeper periods of negative energy balance; which in turn leads to suppressed reproductive performance.

Direct Costs:	Unit	Cost / Unit (€)	Total (€)
Cost of treatments (Trim)			10.00
Antibiotics and NSAIDs (zero milk withdrawal)	0.1	38	3.80
Call out fee (Vet or Trimmer)			60.00
Vet's time (Min) @ € 102.35/hr	15	102.35	25.59
Cost of herdsman's time (Min) @ €15/hr	20	15.00	5.00
Cost of reduced milk yield			
Lower yield (litre) [b]	96		
Net margin per litre of milk (€/litre)		0.25	24.00
Indirect Costs:			
Cost of increased culling			
Percentage increased risk of culling [c]	4		
Cost of culling a cow		600.00	24.00
Cost of longer calving interval			
Number of extra days [c]	9		
Cost of an extra day		3.50	31.50
Cost of extra services			
Number of extra services [c]	0.39		
Cost of service (€/straw)		22.00	8.58
Total Cost of a Case of WLD			€226.67

a. WLD in this calculation includes a 10 per cent incidence of severe cases of foot abscess or toe necrosis
b. Milk yield loss with WLD = 1.6 per cent reduction in annual milk yield for a MS 2 cow (O'Connor et al, 2023) from a herd with an average herd 305 day yield of 6000L
c. Taken from: Esslemont, R. J., Kossaibati, M. (2002). "The cost of poor fertility and disease in UK dairy herds." Daisy research report No.5.

Table 2: Cost of White Line Disease (WLD) [a].

Figure 4: **Interdigital Necrobacillosis/foul in the foot/footrot.**

This is seen as lower submission rate to first service (Somers et al, 2015), delayed ovarian cyclicity (Garbarino et al, 2004), reduced conception rate (Bicalho et al, 2007; Alawneh et al, 2010; Mellado et al, 2018), increased interval between calving and conception (Alawneh et al, 2010), and increased incidence of ovarian cysts (Melendez et al, 2003). Lame cows also seem to be more prone to uterine infections post-partum and have higher pregnancy losses (Tsousis, 2022) As with milk yield, the timing of the lameness event is critical in determining the extent of reduced reproductive performance (Lucey et al, 1986); if it occurs later in lactation after the establishment of pregnancy, the effect will be less than if it occurs before first breeding. However, the effect of late lactation lameness on reproductive performance in the subsequent lactation has yet to be investigated. Also influencing the effect on reproductive performance are the type and severity of lameness (DoleCheck and Bewley, 2018).

Huxley (2013) summarised a number of studies that examined the effects of lameness on reproductive performance. Key effects noted include: a mean of seven days longer time to first service, 30 days increase in days open, 20 per cent lesser conception rate, and 1.2 more services per conception. Recent Irish research demonstrated that MS2 could increase the calving interval length by 3.5 days, whereas MS3 could increase it by six days (O'Connor et al, 2020).

Lameness and culling

Most research shows that lame cows are more likely to be culled (Booth et al, 2004; Machado et al, 2010). A recent study in Spain reported that if a heifer had a case of solar ulcer or white line disease in her first lactation, this reduced her productive life by 71 days (Charfeddine, N. and Perez-Cabal, M.A., 2017). Irish research has found that as mobility score increased, so too did the risk of a cow being culled. A cow with MS1 was 16 per cent more likely to be culled than a cow with perfect mobility, a cow with MS2 was almost 50 per cent more likely to be culled, and a cow with MS3 was nearly four times as likely to be culled (O' Connor et al, 2020). It is challenging to obtain a true figure for the number of cows being culled due to lameness, because in many cases the recorded reason may be infertility, when in fact the cause of the reduced fertility may be lameness. This is an area that warrants further research.

Direct Costs:	Unit	Cost / Unit (€)	Total (€)
Cost of treatments (Trim/exam; antibiotic spray; NSAID)			27.00
Call out fee (Vet or Trimmer)			60.00
Vet's time (Min) @ € 102.35/hr	10	102.35	17.06
Cost of herdsman's time (Min) @ €15/hr	20	15.00	5.00
Cost of reduced milk yield			
Lower yield (litre) [a]	96		
Net margin per litre of milk (€ / litre)		0.25	24.00
Indirect Costs:			
Cost of longer calving interval			
Number of extra days [b]	17		
Cost of an extra day		3.5	59.50
Cost of extra services			
Number of extra services [b]	0.39		
Cost of service (€/straw)		22.00	8.58
Total Cost of a Case of Digital Dermatitis			€201.14

a. Milk yield loss with WLD = 1.6 per cent reduction in annual milk yield for a MS 2 cow (O'Connor et al, 2023) from a herd with an average herd 305 day yield of 6000L
b. Taken from: Esslemont, R. J., Kossaibati, M. (2002). "The cost of poor fertility and disease in UK dairy herds." Daisy research report No.5.

Table 3: Cost of digital dermatitis.

Estimating cost of lameness

Many studies have used different methods to estimate the costs of lameness, both in terms of the costs of lameness in general (partial budget, Guard, 2008; simulation model, Liang et al, 2017) and also the costs relating to individual specific claw disorders (partial budgeting, Willshire and Bell, 2009; dynamic optimisation programming, Cha et al, 2010; deterministic model, Charfeddine and Perez-Cabal, 2017). Estimating the precise cost of lameness is problematic for a number of reasons. Few studies to date have included costs associated with lameness control or prevention, interactions with other diseases, interaction of different lesion types with each other, recurrence of lameness, and losses associated with animal welfare (including the effect on consumer perception, which may affect market demand for dairy products; Dolecheck and Bewley 2018).

Direct Costs:	Unit	Cost / Unit (€)	Total (€)
Cost of treatments (antibiotics; NSAIDs) [a]			31.25
Call out fee (Vet or Trimmer)			60.00
Vet's time (Min) @ €102.35/hr	10	102.35	17.06
Average callout charge per cow (€75/3 cows)		25.00	25.00
Cost of herdsman's time (Min) @ €15/hr	20	15.00	5.00
Cost of milk withdrawal [b]			
7 days milk at 23 litres/day	161		
Net margin per litre of milk (€/ litre)		0.25	40.25
Cost of reduced milk yield			
Lower yield (litre) [c]	150		
Net margin per litre of milk (€ / litre)		0.25	37.50
Indirect Costs:			
Cost of increased culling			
Percentage increased risk of culling [d]	4		
Cost of culling a cow		600.00	24.00
Cost of longer calving interval			
Number of extra days [c]	17		
Cost of an extra day		3.5	59.50
Cost of extra services			
Number of extra services [c]	0.39		
Cost of service (€/straw)		22.00	8.58
Total Cost of a Case of Foot Rot			€308.14

a. The cost of treatment of footrot was based on the average cost of 5 days of oxytetracycline/penicillin and one treatment with meloxicam
b. Milk withdrawals would not be present if a 2nd generation cephalosporin and zero milk withdrawal NSAID was used
c. Taken from: Esslemont, R. J., Kossaibati, M. (2002). "The cost of poor fertility and disease in UK dairy herds." Daisy research report No.5.
d. Culling risk associated with severe cases involving ascending cellulitis

Table 4: Cost of foot rot.

Estimate of costs for individual hoof conditions

In Tables 1 to 5, we used a simple calculation to estimate

Type of Lameness	Digital Dermatitis Cost (€)	WLD Cost (€)	Sole Ulcer Cost (€)	Total Cost
Low Prevalence (%)	5	5	5	
Total cost of a single case	201.14	226.67	536.52	
Low Prevalence Cost for 100 Cow Herd	€1,005.70	€1,133.35	€2,682.60	€4,821.65
Moderate Prevalence (%)	10	10	8	
Total cost of a single case	201.14	226.67	536.52	
Moderate Prevalence Cost for 100 Cow Herd	€2,011.40.	€2,266.70	€4,292.16	€8,570.26
High Prevalence (%)	20	20	10	
Total cost of a single case	201.14	226.67	536.52	
High Prevalence Cost for 100 Cow Herd	€4,022.80	€4,533.40	€5,365.20	€14,191.40

Table 5: Modelled herd cost of lameness cases for 100 cows/year.

the cost of a number of the most important conditions for an individual cow in Ireland. The tables show the costs of lameness calculated for a 100-cow herd, in three different lameness prevalence scenarios. The calculation can be tailored to each individual herd based on the prevalence of lameness and lesion types identified.

Take home message

Lameness is a costly condition and can be a significant source of lost profit for farmers. The other great cost is to the welfare of the cow herself. Taking steps to reduce lameness prevalence within the herd will improve cow welfare and increase farm profitability.

For further information on lameness prevention and management, see https://animalhealthireland.ie/bulletin-cat/hoof-healthcheck-bulletin/ and https://www.teagasc.ie/publications/2022/reducing-lameness-in-irish-dairy-herds.php.

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READER QUESTIONS AND ANSWERS

1. WHAT IS THE THRESHOLD OF LAMENESS PREVALENCE ABOVE WHICH INTERVENTION IS NEEDED?

- **A.** Five per cent
- **B.** 10 per cent
- **C.** 15 per cent
- **D.** 30 per cent

2 WHICH ANSWER BELOW IS INCORRECT? LAMENESS CAUSES ECONOMIC LOSS THROUGH:

- **A.** Reduced milk production
- **B.** Reduced reproductive performance
- **C.** Cost of hoof trimming and veterinary treatment
- **D.** Delayed culling

3. WHICH OF THE BELOW STATEMENTS IS CORRECT:

- **A.** Research suggests a case of solar ulcer or WLD in the first lactation can reduce the productive life of a heifer by 17 days
- **B.** If a lameness event occurs before first breeding, the effect on reproductive performance will be less than if it occurs after the establishment of pregnancy
- **C.** The total annual cost of lameness for a 100-cow herd with a 10 per cent prevalence of digital dermatitis, 10 per cent prevalence of WLD, and eight per cent prevalence of sole ulcer is estimated to be €8,750.26
- **D.** Recent Irish research reported that MS2 could increase the calving interval length by two days

4. IN A RECENT STUDY, THE MILK YIELD LOSSES (PERCENTAGE OF AVERAGE YIELD) ASSOCIATED WITH MS3 IN IRISH DAIRY COWS WAS REPORTED TO BE:

- **A.** 1.6 per cent
- **B.** 6 per cent
- **C.** 20 per cent
- **D.** 50 per cent

5. THE TOTAL ESTIMATED COST OF A CASE OF WHITE LINE DISEASE IN AN IRISH COW IS ESTIMATED TO BE:

- **A.** €227
- **B.** €537
- **C.** €201
- **D.** €308

ANSWERS: 1B; 2D; 3C; 4B; 5A