

## Review

# Unveiling the Multifaceted Causes of Lameness in Dairy Cattle

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## Abstract

Lameness in dairy cows is a serious issue that not only affects the health and wellbeing of animals but also affects the economic status of dairy farms. Lameness is the result of stress and pain, ultimately leading to production losses. Lameness is not only the cause of the decrease in production at the dairy farm but is also a welfare issue. Lameness can be caused by many factors, most notably health issues, housing and management, nutrition, and infections. It is important to understand the causes of lameness in dairy cattle in order to prevent the lameness of animals at the farm. A good understanding of the causes can help in developing better regimes for control of this health issue, formulating housing conditions at the farm, and adapting preventive measures to prevent productive losses due to lameness. From housing to feeding and from management to hoof, health issues should be addressed in the daily routine at a farm to prevent lameness in cows. This review article will delve deeply into the causative factors that are the source of lameness in dairy cattle, ultimately causing dairy losses at the farm.

## Introduction

Lameness in dairy cows is referred to as any abnormality that leads to difficulty or reluctance in movement or standing and is characterized by pain and inflammation of the hooves (Ramanoon *et al.*, 2018). (Ramanoon *et al.*, 2018) It is a concern for both the well-being and productivity of dairy animals. In fact, it ranks as the economic loss on dairy farms following mastitis and infertility (Thomsen *et al.*, 2023). Studies suggest that a substantial percentage of dairy cows, ranging from 25% to 50%, experience lameness at certain points in time (Warnick *et al.*, 2001). This issue raises concerns among farmers, veterinarians, and animal welfare advocates alike (Whay & Shearer, 2017). Lameness can be caused by factors such as health problems, inadequate nutrition, management practices, infectious agents, and different physiological or environmental conditions (Kilic *et al.*, 2007).

Identification and prevention of lameness is crucial in order to ensure welfare and wellbeing

and to ensure maximum productivity by the dairy herd (Nielsen *et al.*, 2023; Riaboff *et al.*, 2021). This condition can be prevented by early identification, proper nutrition, and good management practices at the farm (Van Nuffel *et al.*, 2015). Lameness is a concern in dairy farming that affects both the well-being of individual cows and the economic sustainability of dairy operations (Af Sandeberg *et al.*, 2023). Lameness in dairy cows can be identified by various signs and symptoms. It is crucial to keep an eye on the signs and symptoms in order to ensure the production and welfare of dairy animals at the farm (Westin *et al.*, 2016). The evident signs of lameness include limping, shifting weight, standing with a hunched back, and reduced activity (Kester *et al.*, 2014).

In this article, we will examine the causes of lameness. Lameness, which can be seen through walking or posture, can stem from various factors (Robcis *et al.*, 2023). The nutritional causes include deficiency or excessive amounts of

essential nutrients, i.e., carbohydrates, proteins, and fats (Bran *et al.*, 2019). Lack of minerals such as calcium, zinc, selenium, etc. in the diet can also contribute to lameness in dairy cows (Zhao *et al.*, 2015). Vitamin-deficient feed can also cause lameness in cattle on the farm. These include causes like dermatitis and foot rot, as well as non-infectious causes such as laminitis and injuries. Conformational issues like over-claw trimming and genetic predispositions also contribute to its prevalence. Environmental factors like flooring conditions and overcrowding play a role, along with metabolic causes such as imbalances. Understanding that lameness is often influenced by these factors emphasizes the importance of understanding in order to develop effective prevention and management strategies (Griffiths *et al.*, 2018).

Lameness can be prevented by providing a balanced diet to animals at the dairy farm, providing proper hoof care, trimming, and maintaining a clean, healthy, and optimal environment at the farm (Garvey, 2022). Biosecurity measures and proper veterinary care can also help in reducing the problem. Early detection and preventive measures can prevent the onset of the disease at the farm, so it is better to examine the animals at the farm regularly for early identification and treatment (Dutton-Regester *et al.*, 2018). As the dairy industry evolves, addressing and reducing the causes of lameness becomes not only a responsibility for animal welfare but also a strategic necessity for optimizing herd health and productivity for better economic results and the welfare of animals (Sadiq *et al.*, 2019). This article explores these causes to provide a foundation for comprehension of lameness in dairy cattle and the implementation of targeted interventions to control and prevent it. Table 1 show the economic impact of lameness in dairy cattle.

## 2. Causes of Lameness:

### 2.1. Hoof Health Issues:

Hoof health issues directly contribute to lameness in dairy cattle. Hoof health issues, including digital dermatitis, interdigital dermatitis, and interdigital phlegmon, play a major role in causing lameness in dairy animals. Prevention and treatment of hoof-related issues are crucial in preventing lameness in dairy animals.

#### 2.1.1. Digital Dermatitis (Hairy Heel Warts):

It is a bacterial infection affecting the skin, mainly the interdigital space between the claws (Wilson-Welder *et al.*, 2015). Bovine digital dermatitis is primarily caused by a class of bacteria called Treponemes (Clegg *et al.*, 2016). The major way through which bacteria enter the digital skin of healthy cows is via bacteria in the manure of carrier animals (Bell *et al.*, 2023). It is usually caused by unhygienic conditions on the floor of the pen or stall. Cleaning the area of farm pens or stalls can prevent digital dermatitis effectively (Sullivan *et al.*, 2014). Maintaining hygienic conditions, such as a clean, dry environment for cows at the dairy farm, can be helpful regarding the control of this disease (Orsel *et al.*, 2018). In endemic areas, it is necessary to use prevention procedures, i.e., effective foot-bathing and disinfection trimming equipment, to prevent this disease (Gillespie *et al.*, 2020).

#### 2.1.2. Interdigital Dermatitis (Heel Erosion):

Interdigital dermatitis is a mixed-bacterial infection caused by *Dichelobacter nodosus* and *Treponema* spp. (Usié *et al.*, 2023). It is characterized by inflammation of the superficial skin between the claws and heel bulb (Van Metre,

**Table 1. Economic Impact of Lameness in Dairy Cattle**

Area of Impact	Cost Estimate (per cow per year)	References
Decreased milk production	Up to \$500	(van den Borne <i>et al.</i> , 2022)
Increased culling rate	Up to \$1000 (per cow)	(Warner <i>et al.</i> , 2022)
Veterinary treatment	Up to \$200	(Bewley & Dolecheck, 2018; Ózsvári, 2017)
Reduced fertility	Up to \$300	(Enting <i>et al.</i> , 1997)
Decreased labor efficiency	Up to \$100	(Edwardes <i>et al.</i> , 2022)

2017). The lesions are localized on the plantar surface of the hind foot, from the interdigital space and heel bulb to the accessory digits. It also causes the erosion of the skin present at the heels (Robinson *et al.*, 2023). The disease is mainly transmitted through the wounds that are caused by improper hoof trimming. The bacteria get into the healthy cows through exposure to urine and manure (Schaub *et al.*, 2023). This results in skin damage and causes dermatitis in the interdigital spaces of animals. This causes the cow to have difficulty moving, causing behavioral problems such as pain and lameness, hence causing production losses at the farm (Jury *et al.*, 2021). The disease can be prevented through corrective trimming of heels and feet by trimming cattle herds only with the help of a trained expert (ÇOBAN & KUMANDAŞ). Regular cleaning and maintaining a clean and dry floor environment, along with regular foot baths for dairy animals, can be beneficial in preventing the onset of this disease on the farm (Edwardes *et al.*, 2023).

### 2.1.3. Interdigital Phlegmon (Pasture Foot Rot):

Interdigital phlegmon (IP) is an infectious hoof disease in cattle that has been the oldest known cause of lameness. The affected cow shows slight lameness, which becomes more prominent as the infection progresses (Syring *et al.*, 2019). It is characterized by inflammation and infection of soft tissues, the interdigital spaces, and the bulbs of the heels of dairy animals (Fürmann *et al.*, 2024). The bacteria that majorly cause interdigital phlegmon are *Dichelobacter nodosus*, *Porphyromonas levii*, *Prevotella melaninogenica*, *Treponema* spp., and *Trueperella pyogenes*. (Kontturi *et al.*, 2019). The conditions that contribute to the introduction of disease to the farm include excessive exposure of feet to humidity, susceptibility to abrasions, and the introduction of carrier cattle to the healthy herd (M. Kontturi *et al.*, 2020). The prevention of interdigital phlegmon is done by maintaining a clean, dry environment for cows and avoiding contact with infected areas. The quarantine and screening of newly introduced cows are also crucial steps in preventing this infectious disease at the farm (Kontturi *et al.*, 2017).

## 2. Poor Nutrition:

Balanced nutrition is essential for an animal to maintain its normal physiological activities and production. Nutrition is a source of nourishment; in contrast, poor nutrition can also contribute to lameness in dairy cattle.

### 2.1. Proteins

Proteins are the major requirement of dairy cows and should not be more than 16% of their daily ration (Silva & Oliveira, 2023). Proteins are crucial for developing muscles in the whole body, particularly in the weight-bearing regions, i.e., the legs (Shamshidin *et al.*, 2023). The most critical muscle in this regard is the gastrocnemius muscle and tendon that are essential for normal rising and weight bearing by the dairy cows. The diet insufficient of proteins results in ultimate lameness of dairy cattle (Neethirajan, 2023).

The second major concern in this regard is feeding of excessive amount of proteins or feeding of cows with non-rumen degradable proteins (Bahrami-Yekdangi *et al.*, 2016). The ration fed to cows with these characteristics can increase lameness due to the overproduction of ammonia in the rumen. This can lead to unnecessary weight bearing by cattle and can cause increased ammonia concentration in the blood (Nazifi *et al.*, 2012). Hyperammonemia can damage the sensitive lamellae and corium in the hoof. This ultimately results in lameness in cows that are fed a diet high in proteins (Sinclair *et al.*, 2014).

### 2.2. Carbohydrates

Carbohydrates are the most important part of the diet of dairy animals, accounting for about 60–80% of their total mixed ration (Ishler & Varga, 2001). However, consuming more carbohydrates than the normal requirement can be harmful to dairy animals because it results in factors contributing to lameness. If cows are fed a diet with an excessive amount of fermentable carbohydrates, for example, a diet rich in grains, it will alter the pH of the rumen of the animal, hence leading to acidosis (Long *et al.*, 2021). Acidosis may trigger the release of endotoxins such as histamine by the body. These toxins cause vasoconstriction that leads to laminar

destruction and hoof deterioration, contributing to lameness (Hernández *et al.*, 2014).

### 2.3. Fats

Fats are an essential need of dairy cows, which account for about 5–6 percent of the diet of high-producing cows (Council, 2001). Fats are essential for the development of the fat cushion present between the foot bone and hoof wall, the digital cushion (Palmquist & Jenkins, 2017). The digital cushion (DC) plays an important role in absorbing and dampening forces applied to the foot and therefore supporting internal structures. A diet that lacks the proper amount of fat content results in a thin or malformed digital cushion. Cows that have a thinner fat cushion between the foot bone and hoof wall are unable to move properly and show lameness (Shearer *et al.*, 2012). This can be prevented by maintaining a sufficient amount of fat in the diet of dairy cattle. For this purpose, the required amount of concentrates, edible oils, and feed additives can be used along with roughages (Logue, 2011).

## 2.4. Minerals

### 2.4.1. Calcium

Calcium is required in the amount of 0.75 to 1 percent of the dry matter of a dairy animal (Council, 2001). Calcium plays a vital role in the keratinization and maturation of the claws of a cow. Calcium is needed for the strength and movement of muscles throughout the body, particularly the thighs and hooves (Lean *et al.*, 2013). It is needed in a significant amount for the formation of keratinocytes; it acts as an activator of an enzyme called epidermal transglutaminase, which is essential for the formation of the cell membrane (Köglberger, 2013). A study by Barbosa *et al.* reported that serum calcium levels were lower in lame cows as compared with healthy cows. Lack of sufficient calcium in the diet leads to the malformation of the hooves of dairy cows, which are weak and soft, hence causing lameness in dairy animals (Barbosa *et al.*, 2016).

### 2.4.2. Phosphorous

Phosphorus plays an integral role in the development of healthy hoofs. Phosphorus and

calcium are bound together in a specific ratio to promote proper hoof growth (Sayiner *et al.*, 2020). Imbalances in these ratios result in complications in hoof formation, such as hoof fragility (Jubb *et al.*, 1993). This fragility causes difficulty in the movement of cows, thereby leading to lameness in dairy cows (Langova *et al.*, 2020).

### 2.4.3. Magnesium

Magnesium is an important factor in the distribution, absorption, and deposition of calcium. A deficiency of calcium can lead to poor bone formation and the weakness of bone tissues (Wawrzyniak & Suliburska, 2021). Magnesium also plays a crucial role in the keratinization of hoofs (Freitas *et al.*, 2023). The process of keratinization needs a lot of energy, and magnesium is required in an adequate amount in the diet of cattle because it triggers energy production by activating pyruvate carboxylase (Rose, 2021).

### 2.4.4. Zinc

Zinc plays an important role in deposition of keratin on heels and hardening of hoof. Lack of availability of zinc in diet can lead to malformation of keratin tissue and softness of claws that can ultimately causes lameness of dairy cows (Singh *et al.*, 2019).

### 2.4.5. Selenium

Selenium is an essential and toxic element when given more than the required amount. This is because selenium is associated with lameness in cases of deficiency and toxicity. Animals that are fed a diet deficient in selenium show signs of muscular dystrophy (Hidioglou *et al.*, 1985). Muscular dystrophy is a serious problem that makes it difficult for cattle to move freely, ultimately leading to lameness in the cow (Zarczynska *et al.*, 2017). On the other hand, chronic selenium toxicity in dairy cattle causes malformation of the claw, lameness, stiffness of joints, hair loss from the tail, dullness, loss of appetite, and emaciation (Saha *et al.*, 2016).

### 2.4.6. Copper

Copper is essential for the desmosine cross-linkages of collagen. Thus, it is crucial for strengthening the matrix elements of bone,



**Table 2. Nutrition and Lameness**

Nutrient	Deficiency Symptoms	Excess Symptoms	Importance for Hoof Health
<b>Protein</b>	Reduced milk yield, poor body condition	Weight gain, milk fever	Provides building blocks for hoof tissue
<b>Carbohydrates</b>	Acidosis, laminitis	Weight gain, milk fever	Source of energy; excess can disrupt rumen pH
<b>Fat</b>	Thin digital cushion, lameness	Weight gain, fatty liver disease	Provides energy and cushioning for the hoof
<b>Calcium</b>	Milk fever, laminitis	Kidney stones	Essential for bone and hoof health
<b>Phosphorus</b>	Weakness, lameness	Stiffness, joint problems	Essential for bone and hoof health
<b>Magnesium</b>	Muscle tremors, seizures	Loose stools, diarrhea	Important for nerve and muscle function
<b>Zinc</b>	Hair loss, dermatitis	Toxicity	Important for hoof tissue growth and repair
<b>Selenium</b>	Weakness, muscle problems	Toxicity	Antioxidant; protects against hoof infections
<b>Copper</b>	Coat changes, anemia	Liver damage	Important for tissue repair and immunity
<b>Biotin</b>	Brittle hooves, hair loss	None	Essential for hoof growth and strength
<b>Vitamin D</b>	Rickets, poor bone growth	None	Important for calcium absorption and bone health
<b>Vitamin E</b>	Muscle weakness, immune suppression	None	Antioxidant; protects against cell damage

cartilage, and other connective tissues (Erickson & Kalscheur, 2020). Animals that are not fed with an adequate amount of copper in their diet face abnormal collagen synthesis that may lead to osteoporosis and increased fragility of bones and cartilage, possibly of the legs, causing lameness (Evans, 2013).

## 2.5. Vitamins

### 2.5.1. Biotin

Biotin is a co-factor for many enzymes and is involved in many metabolic reactions. It is the most important vitamin involved in keratinization (Queiroz *et al.*, 2021). Biotin contributes to the structure and quality of hooves in both cows and horses. It is essential for the production and integrity of keratinized tissues, i.e., claw horn (Kanitakis *et al.*, 1987). It also boosts the rate of healing of claw lesions and promotes healthier horn growth (Fitzgerald *et al.*, 2000). Biotin supplements in feed have been found to positively impact various foot lesions in animals (Hedges *et al.*, 2001). It can help maintaining hoof health and reduce hoof issues (Fritsche *et al.*, 1991). It is synthesized naturally in the rumen of all dairy cows, but its amount varies from type to type of feed ration given to the dairy animals. It is synthesized only when a cow is fed an adequate amount of roughages (Seck *et al.*, 2017). So the biotin is not

synthesized adequately in the gut of dairy cows, resulting in hoof issues that result in lameness in dairy cows (Castagnino *et al.*, 2016).

### 2.5.2. Vitamin D

Vitamin D plays an important role in the absorption of phosphorus and calcium from the diet into the bones. Thus, it is essential for bone health. Dairy cows that are fed a supplementation of vitamin D in their diet have been observed to show greater efficiency in absorbing nutrients and preventing skeletal abnormalities that can cause lameness. In dairy cattle, strong bones are essential to support their weight and prevent lameness (Alabada & Saleh, 2020).

### 2.5.3. Vitamin E

Vitamin E is an essential vitamin for hoof health. Vitamin E plays a role as an antioxidant and anti-inflammatory in the body of animals. It can prevent damage to weight-bearing joints that occurs due to inflammation (Kibar *et al.*, 2016). It indirectly helps in the reduction of lameness by decreasing the inflammation of the joints of dairy cattle. Thus, an adequate amount of vitamin E is required in the diet of dairy animals to reduce lameness (Yakan, 2021).

## 3. Overfeeding:

Overfeeding of the grains to cows can lead to a drop in the pH of the rumen, known as sub-

acute ruminal acidosis (SARA). This metabolic disease in dairy cattle can cause discomfort and toxicity and lead to histamine-mediated responses in the animal's body. So it causes lameness in dairy cow herds. Overfeeding also causes the formation of claw lesions, such as sole ulcers. Thus, a balanced diet is required to ensure hoof health and prevent lameness in dairy cattle (Abdela, 2016).

#### **4. Housing and Environment:**

##### **4.1. Wet and Dirty Bedding:**

Clean, hygienic, and dry bedding is essential for maintaining hoof health. The herd that is provided with wet and dirty bedding is prone to bacterial contamination that leads to infections and lameness. The bacteria that usually transfer through wet and contaminated bedding are *E. coli* and *Streptococcus*. The wet environment damages the skin of cattle and causes damage to the claw-exposed layer (Kull *et al.*, 2017). This causes contamination and transmission of many bacteria, such as FOOT ROT disease, leading to infection and lameness. Wet and dirty bedding brings discomfort to the cows in pens and stalls. This increases the standing time and decreases the lying time of cattle. This contributes to fatigue and leads to lameness (Singh *et al.*, 2020).

##### **4.2. Poor Flooring:**

Cows are animals in pastures and green areas. They prefer soft and comfortable surfaces for walking and lying. Too much hard flooring can cause abnormalities such as claw overgrowth and difficulty walking, which can contribute to lameness (Alsaad *et al.*, 2017). The hardness of the floor can contribute to laminitis, which can lead to hoof disorders such as sole ulcers and white line disease, which are major contributors to lameness. These surfaces also lead to injuries and falls in cow herds, which also contribute to lameness (Marcia I Endres, 2017).

##### **4.3. Overcrowding:**

There is sufficient space, i.e., 0.6 m<sup>2</sup>/cow, in the cubicle for a dairy cow. If the cows are confined to cubicles that have insufficient space, their resting or lying time will decrease. This will bring restlessness and fatigue to the cows that are

confined in a cubicle and will result in lameness (Mee *et al.*, 2019). There is another concern that arises due to overcrowding: behavioral problems. The cows that are overcrowded will show aggressive behavior and fights. This can lead to traumas and injuries that ultimately be a source of lameness in dairy cows at the farm (Nogues, 2023).

#### **5. Inadequate Foot Care:**

Feet abnormalities are the major cause of lameness in dairy cattle. Trimming plays an important role in maintaining cattle welfare and production by addressing hoof issues that can lead to lameness (M. Sadiq *et al.*, 2021). Trimming is to be done regularly; if the trimming is infrequent, claw overgrowth occurs, and if it is not done properly, it can worsen the condition. Regular and effective trimming has been reported to control the lameness in dairy cows (M. B. Sadiq *et al.*, 2021).

#### **6. Genetic Predisposition:**

Genetics also influences the occurrence of lameness in dairy cows. Several genetic factors are associated with lameness in dairy cattle, such as hoof size, strength and angle, disease resistance, joints, and rumps (Barden *et al.*, 2022). The animals with genetic characteristics such as low foot angle, hocking in, and wide rumps have been observed to show a greater extent of lameness (Khansefid *et al.*, 2021). Proper management and extra care are required for the animals that have genetics that make them more susceptible to lameness. Lameness can also be reduced through the genetic selection of animals with the desired phenotypic characteristics of hoofs and claws (Jaques *et al.*, 2023).

#### **7. Infections and Diseases:**

##### **7.1. Foot Rot:**

Infectious pododermatitis contributes to approximately 20% of the total lameness of dairy cattle. It causes hoof inflammation, splayed claws, abscess formation, and necrosis of interdigital spaces (STANOJEVIĆ *et al.*, 2020). It is caused by bacteria, most commonly *Fusobacterium necrophorum*, and sometimes *Porphyromonas levii* and *Dichelobacter nodosus* (Miia Kontturi

*et al.*, 2020). It is a disease of muddy and moist environments. It can lead to serious swelling and cause lameness, ultimately affecting the mobility of dairy animals. It can cause mild to severe lameness, depending on the severity of the infection. The disease can be prevented by maintaining hygienic and biosecurity measures at the farm, along with the timely vaccination of the animals (Niyozov, 2020).

## 7.2. Joint Infections:

Joint infections also have a significant contribution to lameness in dairy cows. The most susceptible joints in this regard are coffin joints. These are the last and most weight-bearing joints located just right at the hoof wall (Akter *et al.*, 2021). The most commonly occurring infection of the joints is caused by a bacteria called *Mycoplasma bovis* (Priyantha *et al.*, 2021). This bacterium infects the joints by damaging the surrounding tissues of the joints, such as the tendon sheath and ligaments. This bacterium gets enter through contaminated feed and injuries. The control of joint infections is necessary to control lameness in dairy cattle (Roche *et al.*, 2023).

## 7.3. Laminitis:

Laminitis is the inflammation of the laminae tissue of the hooves. It is the most common cause of lameness in dairy cattle. The animal suffering from this disorder will show signs including lethargy, weaker horns, abnormal hoof

development, a shortened stride, and foot lifting. (Warner, 2023). It occurs because of the feeding of high amounts of concentrates to dairy cattle, obesity, and toxicity. This affects the gait and movement capabilities of dairy cows, hence contributing to lameness. A balanced diet fed to the herd can prevent laminitis (Bell & Randall, 2021).

## 7.4. Thrush

Thrush is a fungal disease of the hoof of cattle caused by the yeast *Candida albicans*. This disease is responsible for 20% of the lameness in dairy cattle. The area of the affected hood appears to be inflamed, followed by necrosis of the tissue of the hooves. The disease also affects the hoof quality, and it appears to be lethargic, hence causing lameness in dairy cows. The cow shows difficulty with movement, stress, and weight loss. Control of this disease is necessary to prevent lameness in cows (Walker & Niehaus, 2022).

## 8. Reproductive and Metabolic Disorders:

Ketosis is defined as low blood sugar in the blood of dairy cattle. It mostly occurs in high-producing dairy cows during the first few weeks after calving. Ketosis can weaken the bones and joints and affect the movement of dairy cattle (Bhadauria *et al.*, 2020). It can lead to lameness and affect the production of high-producing cows. It can be controlled through postpartum management and a balanced diet (Zhang & Ametaj, 2020). Table2 show the frequency of lameness causes in dairy cattle.

**Table 3. Frequency of Lameness Causes in Dairy Cattle**

Category	Causes	Percentage of Lameness Cases (%)	References
<b>Hoof Health Issues</b>	Digital Dermatitis, Interdigital Dermatitis, Sole Ulcers, White Line Disease	50-72%	(Manske <i>et al.</i> , 2002)
<b>Housing and Environment</b>	Slippery flooring, Rough surfaces, Overcrowding, Poor sanitation	15-29%	(Barker <i>et al.</i> , 2010; Cutler <i>et al.</i> , 2017)
<b>Foot Care and Trimming</b>	Overgrown hooves, Incorrect trimming, Lack of routine trimming	5-10%	(Fossing <i>et al.</i> , 2003; Manske <i>et al.</i> , 2002; Russell <i>et al.</i> , 1982)
<b>Nutrition</b>	Mineral deficiencies (e.g., copper, zinc), Excess protein, Vitamin imbalances	5-10%	(Langova <i>et al.</i> , 2020; Westwood <i>et al.</i> , 2003)
<b>Infections and Diseases</b>	Foot Rot, <i>Mycoplasma bovis</i> , Laminitis	5-10%	(JUBB & MALMO, 1991)
<b>Management Factors</b>	Stressful handling, Poor milking practices, Sudden dietary changes	2-5%	(Marcia I. Endres, 2017; Rouha-Müller <i>et al.</i> , 2009; Salfer <i>et al.</i> , 2018)

Milk fever is a metabolic disorder that is caused by low calcium levels in the blood. It also occurs in high-producing dairy cows within 24 hours of calving. Milk fever can cause pain and inflammation, which can lead to lameness (Malašauskienė *et al.*, 2022).

Reproductive disorders such as retained placentas can cause lameness. Retained placenta can be a secondary cause of lameness because it can be a source of sepsis and bacterial transmission, which can lead to systemic infections that can lead to lameness. Uterine infections can also be a source of lameness in dairy cattle. The uterine infections can cause pain and inflammation, which can cause lameness (Bruinje *et al.*, 2023).

## 9. Stress and Management Factors:

### 9.1. Stress:

Stress is one of the major factors contributing to the lameness of dairy cattle. Stress weakens the immune system and makes animals prone to different infectious diseases. Stress also affects the behavior of animals negatively. Animals show increased aggression that can cause injuries and trauma. It is essential to maintain a stress-free environment to prevent losses due to the lameness of dairy cattle. (Mullan *et al.*, 2020).

### 9.2. Sudden Dietary Changes:

Sudden dietary changes in ruminants affect the normal micro flora of the GIT tract, especially that of rumen. This micro floral change makes animals more susceptible to infectious agents such as trypanosomes. This can lead to inflammation of the hoof and lameness (Elmhadi *et al.*, 2022).

## 10. Insufficient Movement:

Cows should have sufficient space to show their normal behavior on the farm, and they should be provided with a clean and dry environment. The cows should have access to green pastures (Medina-González *et al.*, 2022). If the cows are not provided with sufficient space, it will affect their locomotion scoring. The cows will not be able to move freely, and this can result in the weakness of their hooves. Access to land and pasture is also crucial to

preventing lameness in dairy cattle (Shepley *et al.*, 2020).

## 11. Age and Lifecycle Factors:

The age of cows in the herd also affects lameness. In herds of cows of different ages, older cows and young heifers are more susceptible to lameness. The cows older than 10 years show more signs than cows of younger age. The cows that are younger than 2 years are least susceptible to lameness. Also, the first month after lactation is crucial because most cows are observed to show lameness during this time period. More care and attention should be given to the older cows and young heifers of the herd to prevent losses due to lameness (Browne *et al.*, 2022).

## Conclusion

Preventing and managing lameness requires a holistic approach involving proper nutrition, regular hoof care, appropriate housing conditions, vigilant monitoring, and swift intervention when issues arise. By addressing these causes, dairy farmers can improve the well-being of their cows, enhance productivity, and promote sustainable dairy practices.

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