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THE RESPONSIBLE INNOVATION

Cattle Lameness

TOPIC 7

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- In 1988 he started his own foot trimming ambulatory practice. Over the next 10 years he trimmed more than 100.000 cows. Since his beginnings as a foot care specialist, he has been involved in educational programs for veterinarians and farm workers in many different countries.
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Introduction

*Lameness is one of the **more common issues** in dairy cows and represents an important health problem with clear **repercussions on animal welfare and productivity.** After infertility and mastitis, it is the **third most important cause of economic losses** in the dairy industry. Most lameness occurs at the level of the hoof and more frequently in the hindlimbs.*

Although lameness is clearly a part of veterinary medicine it is also true that many veterinarians do not engage it in their professional practice, possibly because of a lack of time, knowledge, and materials such as the correct instruments or adequate facilities for animal restraint. Therapeutic foot trimming can be difficult as good handling facilitates are needed, as well as adequate instruments and technical knowledge. Incorrect instruments and restraint, can make this task tiring and even dangerous.

Addressing **risk factors** is the main preventive tool veterinarians can use to prevent cows becoming lame. The administration of drugs first requires a prior **diagnosis** so that the **proper treatments** and **correct trimming technique** can be chosen on a case-by-case basis.

1. Aims and objectives

Lameness is a major health issue in dairy herds worldwide. This manual aims to give veterinarians a broad basic and practical overview of the problem, allowing them to focus on cases both from an epidemiological consulting approach as well as with an individual clinical case approach.

Objectives:

- Understand the importance of lameness on animal welfare and productivity.
- Define the general risk factors that influence the dynamics of lameness on farms.
- Help with individual and herd diagnostics.
- Explain the basic approach to surgical and medical interventions.
- Provide some hints to minimising risk and fatigue during interventions so that performing foot trimmings does not become a unpleasant task.
- Try to facilitate surgical interventions for hoof problems.

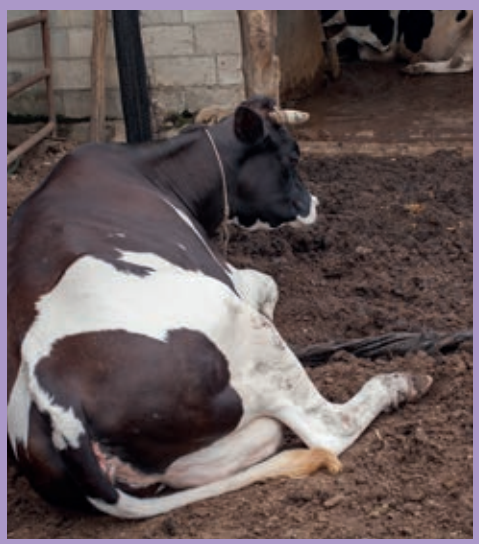
2. Consequences of lameness

2.1. Welfare issues

Lameness affects a very high number of dairy cattle, and farmers tend to significantly underestimate the amount of lameness in their herds.

Studies show that farmers estimate about 5% to 10% of their dairy cow herd suffers from lameness, whereas the average is at least 25%. This welfare problem accounts for a loss of 5% to 10% of farmers' annual income per cow.

Lameness reduces the efficiency of cow milk production, resulting in an estimated average loss of €200 per cow, per year.

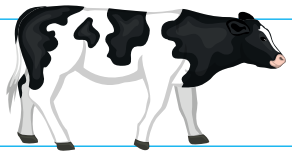


Lameness is a sign that the cow is suffering pain; this pain impairs their movements and has a direct influence on the behaviour of the affected individual. Likewise, it has a negative influence on the animal's social position within the group.

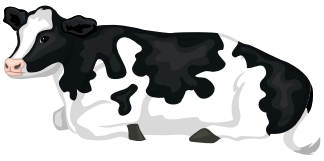
Lame cows are less likely to initiate aggressive interactions, so their capacity to make themselves room to obtain food at eating times or to obtain a cubicle to lie down in when they need it, becomes impaired. In addition, if possible, they spend more time lying down and more frequently do so outside cubicles, and spend less time eating. Their behaviour in cubicles is also altered; if the type of bed provided is not sufficiently soft, the cow becomes scared of the pain it may feel when getting up and lying down, and so they tend to remain standing for longer periods before lying down and get up less often.

Modern intensive milk production systems are highly competitive. **Lameness is a behavioural expression of pain** and is a disadvantage for cows coping with slippery floors and overcrowded places such as feeding or resting areas.

Lame cows will be last choosing positions to lie down in, which usually means they are further away from the milking parlour; thus, precisely the animals that have greater difficulties at walking must travel further.



In addition, they have to wait longer, on foot, to be milked because they are usually the last ones to join the queue.



As a result, when they return from milking, they find it difficult to find a place in the feeding line and cannot always drink when they want to, but rather have to wait for the other cows to leave. They also find it difficult to lie down because the spaces are usually already occupied by the cows that were before them in the queue.

Figure 1:
Behaviour of lame cows.

The expression of lameness is very obvious, even for an untrained observer, and therefore is bad for the diary industry's public image. Thus, in terms of improving animal welfare, is it important not to underestimate this issue. In addition, all these welfare problems obviously translate into productivity problems that can be quantified economically.

We can conclude that the presence of lameness is a clear indicator of the lack of well-being and so can be used to help measure welfare on farms.

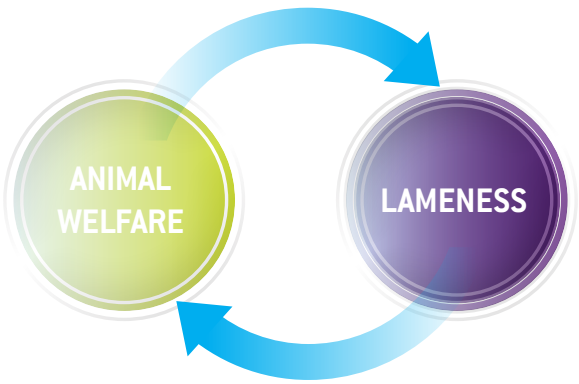


Figure 2: Relationship between Animal Welfare and Lameness.

2.2. Production losses

Lameness is one of the most important endemic diseases present in dairy farming, not only for its effect on economic losses, but also on animal welfare. **A critical factor in estimating costs is the duration of episodes. Cows that are diagnosed and treated correctly within 72 hours from the beginning of the process show limited milk-production losses,** rapidly recover without significant long-term effects on their production curve or on other areas such as reproduction or longevity, and show rapid and recovery of the affected claw.

Despite this, it is more common to find intervention protocols that are slow, animals with extensive lesions, and farms that tend to have high numbers of chronically lame animals and so, suffering significant economic losses. Furthermore, **lameness can be a cause of other metabolic health problems including low fertility and mastitis, because of mobility loss and behavioural changes.**

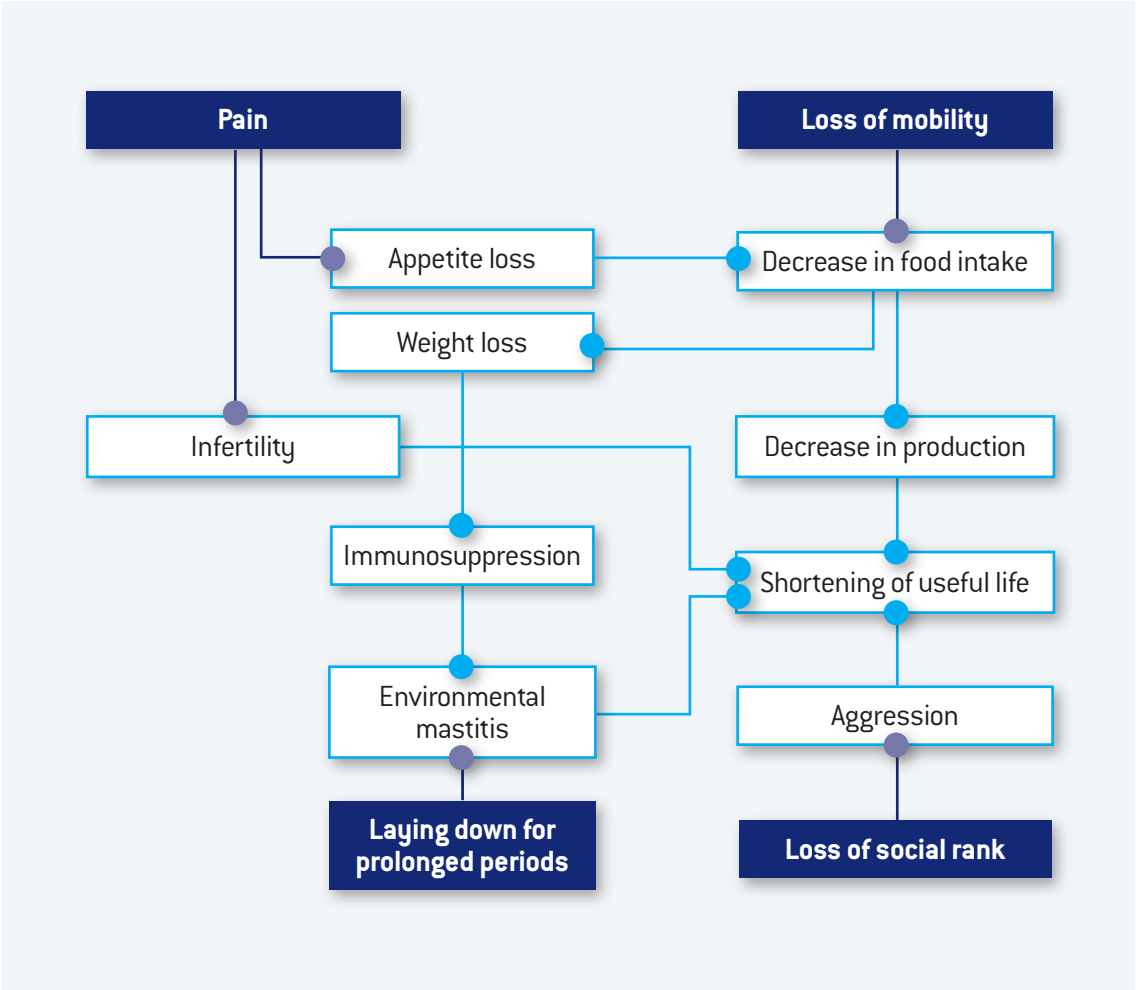


Figure 3: Relationship between lameness, health, and productivity.

When **calculating the costs of lameness**, we must consider the effect of various factors, including:

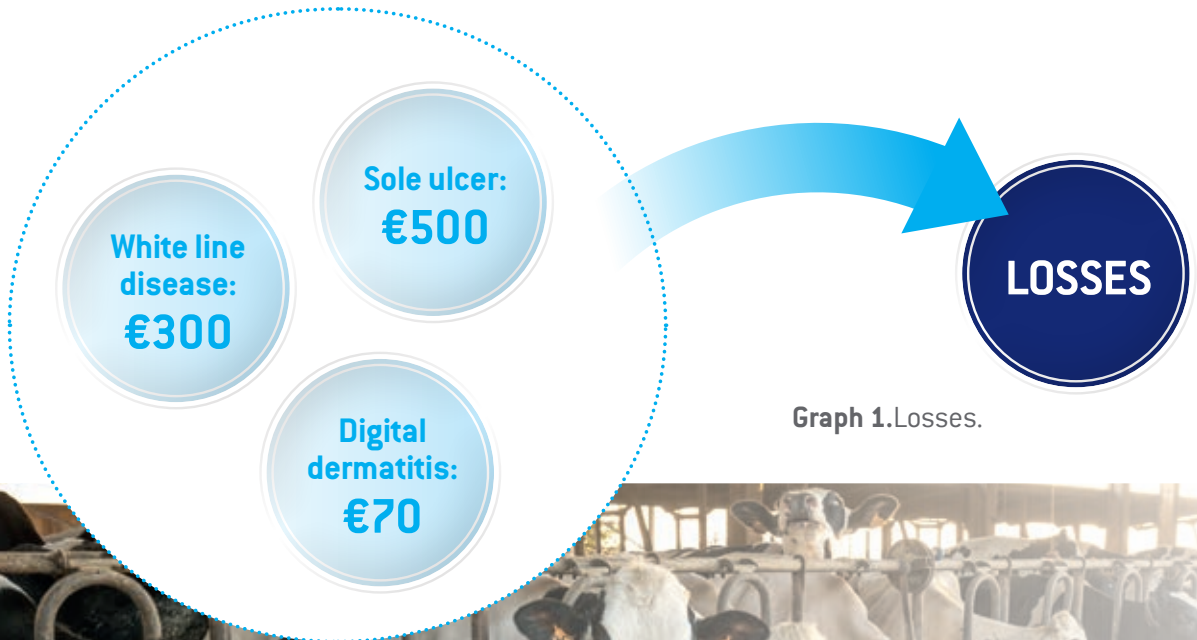
- the incidence of lame animals,
- production loss,
- pregnancy rate,
- and treatment costs,

According to the different types of lameness, the average costs $US and the main consequences, are the following:

Type of lameness	Average cost $US	Main contributor of total cost
Sole ulcer	216.07	Milk loss 38%
Digital dermatitis	132.96	Treatment 42%
Interdigital phlegmon	120.70	Decreased fertility 50%

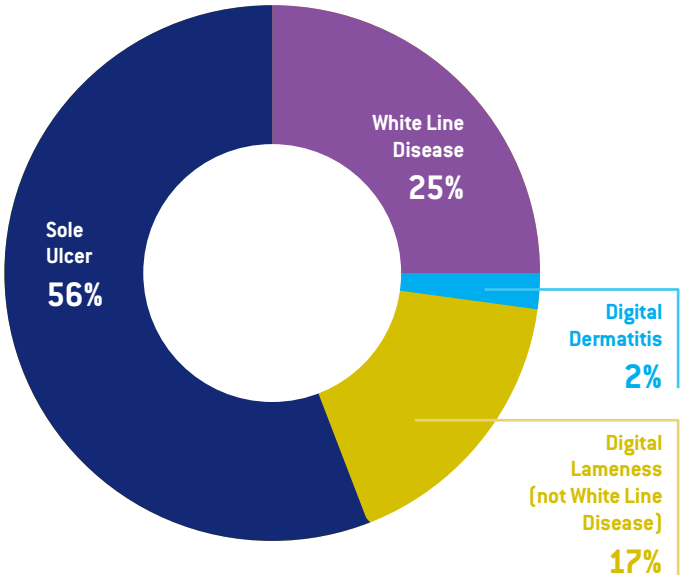
Table 1. The cost of different types of lameness (Cha. E et al., Prev Vet Med. 2010).

The following average costs were established by comparing the data from several studies:



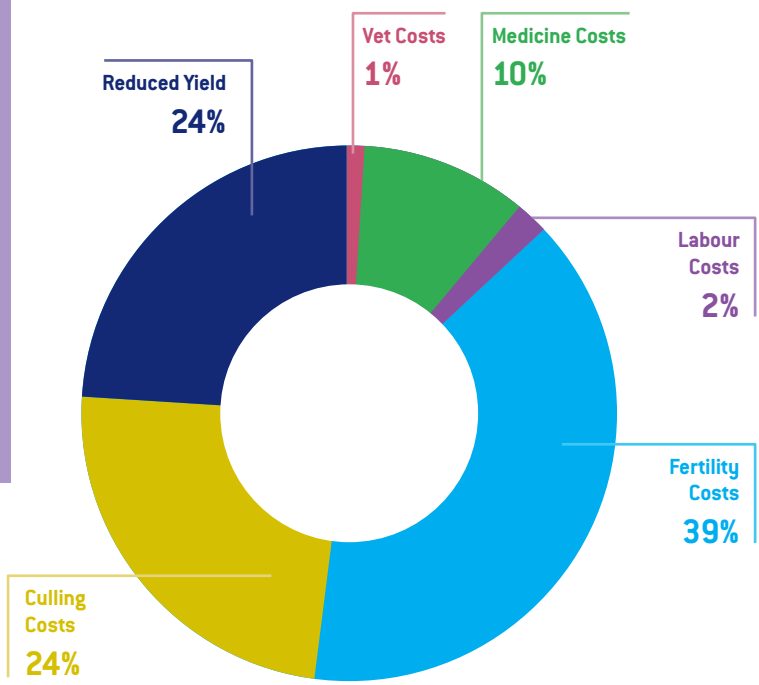
Graph 1. Losses.

Taking into account the type of lesion, the distribution of the annual cost due to lameness in the herd could be as follows:



Graph 2. Distribution of annual cost according to the type of lesion in the herd (Wilsire J.A. et al., Cattle practice 2009).

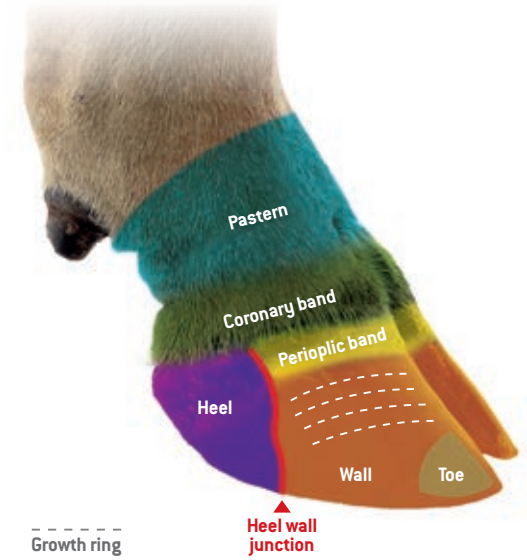
In a typical case, 87% of this cost could be considered the result of production and fertility losses, with the veterinary cost representing only 1%.

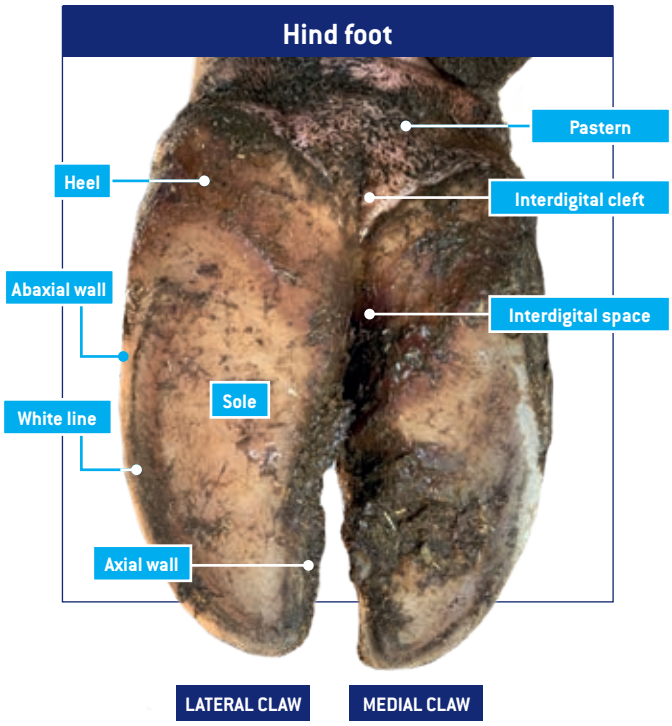


Graph 3. Breakdown of annual cost of lameness per herd (Wilsire J.A. et al., Cattle practice 2009).

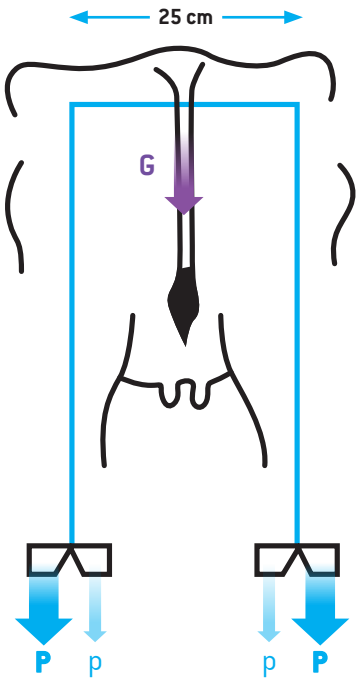
3. Foot anatomy and biomechanics

Bovine feet comprise of two toes, or claws, with an independent ligamentous and tendinous structure that distributes the body weight. Each claw is covered by a horn hoof capsule. Underneath the dermal tissue "corium" produces the hoof. The parts of bovine hooves and feet are shown in the following drawings:





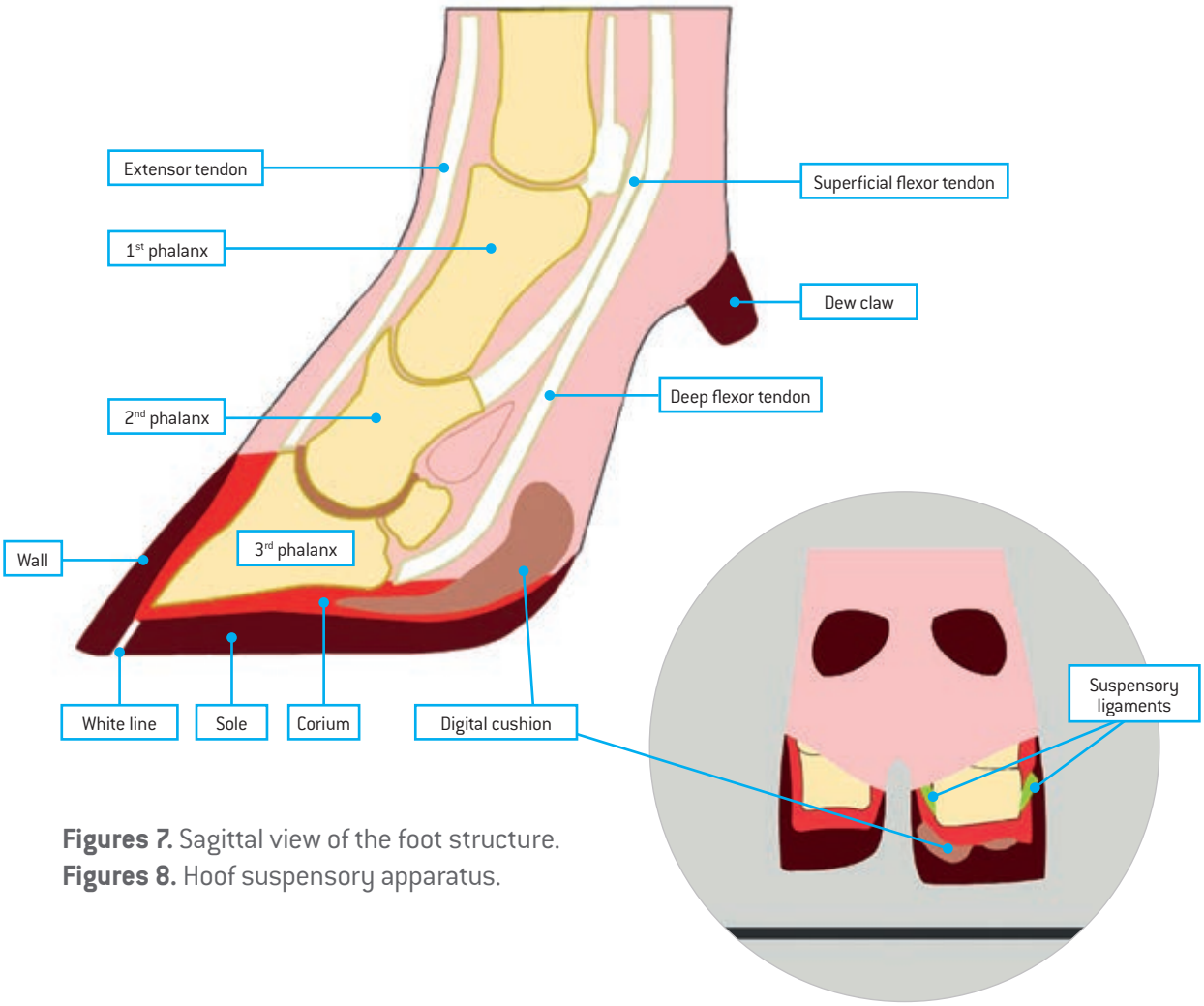
Figures 4 & 5. Parts of the cow hoof.



Cows distribute their weight over all four extremities, downwards along the longitudinal axis, starting from the spine, running through each limb to end in the hooves.

Within the hoof, the weight is transferred from the second to the third phalanx through the foot joint's centre of rotation. The force is supported by adjacent structures: the so-called suspensory apparatus.

◂ **Figure 6.** Weight distribution.
P= Pressure G= Gravity



Figures 7. Sagittal view of the foot structure.
Figures 8. Hoof suspensory apparatus.

The lamellar portion of the corium maintains the phalanx toe tip still so that the shock of the impact of each step during movement is absorbed. In contrast, the caudal portion of the phalanx, located on the hoof heel, is 'loose' and supported on the digital pad to cushion the animal's steps. This combination achieves a stable and flexible suspension of the phalanx and simultaneously makes the animal's steps more agile and able to support large weights. However, **the fact that the corium, located between the bone and the horn tissue of the sole, is under pressure is the main mechanical cause of lameness**.

A cow that usually walks on soft surfaces does not support its weight on the central area of the sole, but on its abaxial ends and its hooves have a surface that is inclined from abaxial to the middle axis.

3.1. Weight distribution

The forefeet support more weight than the hindfeet because the centre of gravity in cows is located in the chest and because of the lever, or rudder, effect exerted by the head and neck combined. During the foot strike sequence, the animal's head and neck direct and stabilise the movement, which influences the forces supported by the it's anterior third, while the posterior third generates this movement. When stationary, cows naturally swing slightly from left to right, in a movement directed from the pelvis.

Figure 9. Balance of weights in stationary cows.

These are smooth movements of about 2.5 cm from one side to the other, but mean that there is a slight deviation along the longitudinal axis and so the weight applied to the lateral hooves is continuously redistributed.

The lateral claws of the hindlimbs naturally support the most pressure, while in the forelimbs, the medial claws support most of the pressure.

Most lameness occurs in the hind lateral claw because of:

Mechanical reasons

The lateral claw supports more weight and when the cow alternates the balance of its hips, it overloads these claws.

Hygienic conditions

The hind-hooves come into increased contact with slurry.

This vicious circle of claw growth and the increased pressures the lateral claws must support cause the cow's posture to adapt, both when stationary and in movement. To try to allow the medial claw to support more pressure by increasing its contact surface area, the hooves of the hindlimbs acquire a lateral angulation. This means that the axis of the whole limb deviates from its start and up to the height of the pelvis. If this deviation persists over time, the hocks (tarsal joints) take on a medial direction to increase the angle of deviation to relieve pressure on lateral claw.

Chronic diseases and their influence on biomechanics

Chronic diseases such as **laminitis,** interdigital **dermatitis and heel horn erosion also have an strong influence on enhancing the unbalance between lateral and medial hind claw.** Because these latter diseases are **chronic**, they **produce abnormal growth, especially in the lateral posterior claw,** and this strongly influences gait biomechanics. That is, they cause alterations in biomechanics, rather than being secondary to biomechanical alterations.

Figure 10. Chronic laminitis, note overgrowth of lateral claw.

Figure 11. Chronic dermatitis with heel horn erosion leading to horn overgrowth.

In adverse conditions, foot disease triggers a vicious circle of lateral hoof corium irritation that generates increased tissue activity, hypertrophy, hyperplasia and growth, imbalances, and irritation among other problems.

This vicious circle of claw growth and the increased pressures on the lateral claws causes the cow's posture to adapt, both when stationary and in movement. To try and allow the medial claw to support more pressure by increasing its contact surface area, the hooves of the hindlimbs acquire a lateral angulation. This means that the axis of the whole limb deviates from its starting point and up to the height of the pelvis. If this deviation persists over time, the hocks (tarsal joints) take on a medial direction to increase the angle of deviation to relieve pressure onto the lateral claw.

Figure 12. Vicious circle of foot disease.

The main reason for routine trimming is to correct this vicious circle.

3.2. Cow foot strides

Foot load

The heel contacts first with the ground, and because it comprises softer and more flexible tissues, it acts to cushion most of the impact. Next, the foot sole contacts the ground, with the toe being the last portion to make contact. The pressures supported are transferred from the heel to the toe.

Propulsion

The cow leans on the toes and raises the limb in order to advance. In turn, this displacement stimulates blood circulation and horn production as the hoof claws are worn down. Under ideal conditions the rate of claw production and wear are balanced and the hooves maintain their natural functionality. For practical purposes this means that in medium and small barns in which cows walk relatively small distances and remain standing for long periods, the animals exert pressure for longer periods on their heels and so more lesions are located in this area. In systems where cows walk a lot, toe injuries are more frequent.

A healthy cow walks with a horizontal and level back. In the case of lactating cows, the width of the hindlimb strides is greater than that of the forelimbs, where the hooves contact the ground following the vertical axis of the extremities and the toes rotate slightly outwards.

Figure 13. Cow that stands and walks normally with flat back and long confident strides.

4. Risk factors

Lameness is a multifactorial disease and is influenced by the interaction of different risk factors. Some of them can be manageable in a short term.

General risk factors

- Climate.
- Season.
- Number of lactations.
- Locomotion.
- Lactation status.
- Individual predisposition.
- Breed.
- Comfort.
- Design and type of bed.
- Cattle density and overcrowding.
- Cow flow and movement.
- Floor type.

Short term manageable factors

- Hygiene.
- Bedding.
- Biosecurity.
- Social integration.
- Metabolism – nutrition.
- The human factor.
- Interaction of risk factors.

4.1. General risk factors

Climate

Hooves are highly hygroscopic and the water content of the horn wall determines its hardness; in humid climates hooves tend to be softer and therefore less resistant. In lower-humidity conditions, hygiene is easier to control, so as a general rule, lameness is less common in dryer climates.

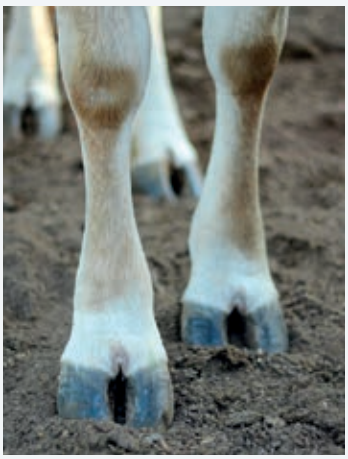
Season

Thermal stress affects the behaviour and metabolism of cows. In temperate climates, lameness is more common in the summer and early autumn; in subtropical and tropical climates, an increase in lameness is associated with the wet season.

Number of lactations

Older cows suffer more lameness related to pododermatitis, especially slow-developing diseases such as chronic laminitis. This same correlation does not apply to contagious infectious diseases such as phlegmon (foul in the foot) and dermatitis that can appear from very early ages.

Locomotion



- Moderate exercise promotes blood circulation and regeneration of horn tissues. Cows that walk long distances, either in grazing systems or large intensive facilities, have a greater risk of suffering excess horn tissue wear, resulting in thin soles and traumas. The frequency of toe wounds among these animals is often high compared to cows that walk less. In contrast, cows that walk very little often present problems related to claw overgrowth, usually in the toes, which results in weight distribution overloads and more injuries in the area closest to the heels.
- Because cows in their first calving are young animals, their gait differs from older cows. In general, they are more nervous and walk faster and more abruptly, which can mean that the impact of their injuries is higher when walking long distances.
- In addition, cows will always have a functional, physical imbalance in weight distribution, which is why the lateral hoof is always a little larger. So-called functional claw trimming aims to correct problems resulting from the chronic diseases mentioned above.

Lactation status

Most of the traditional literature indicates that there is more lameness in the early stages of lactation and so, historically, it has been considered an intrinsic unmanageable factor. However, this is not really the case, with good management in this transition period to minimise the loss of body condition, this situation can be improved and reversed.

Individual predisposition

It is evident that some cows are more prone to suffer from lameness than others. As a general rule, the most productive cows in the herd are most likely to suffer from lameness. There is no correlation between the characteristics of cows' legs (including their straightness) and the appearance of lameness, so trying to minimise lameness using only traditional genetic tools is a difficult prospect. However, as genomic technologies improve, the horizon looks more hopeful.

Breed

The more rustic and less specialised breeds tend to present fewer problems with lameness, although this statement is not categorical because the choice of these types of breed is usually associated with less intensive management. There is also a belief that breeds with dark hooves (Jersey) are more resistant than those with light-coloured hooves (Holstein).
However, there have been no serious studies to prove this assertion. These statements seem to be based on random or nor-experimental observations, because in very intensive handling or unfavourable conditions, these differences between breeds are not evident.

Comfort

Standing time is a key factor in the development of lameness. Cows only become lame when they are standing, therefore, the longer they remain lying down, the lower the probability that lameness will appear and the better the healing prognosis of any existing lameness. The only lesions that appear when cows lie down are hock injuries.

Long milking times and milking frequency negatively influence the appearance of lameness. Similarly, the time cows spend in milking and stanchions also decreases lying time, favouring the appearance of lameness.

Figure 14. Cow with a hock injury.

Design of lying area

Cows lie down more easily in open spaces with soft beds (e.g., straw, dry manure, etc.), thus open yards with this bedding maximise lying time and favour foot health.

Cubicles are another source of lameness problems: they must be designed so that there is sufficient space in front of the cows for them to be able to correctly move so that they can get up without rubbing against the side walls or the neck rail.

Figure 15. Movements made by cows when getting up.

Cattle density and overcrowding

High densities of livestock negatively influence the appearance of lameness. In cubicle sheds, lame cows lose opportunities to lie down when they most need it, and this impedes their recovery.

In open yards, high densities are linked to bed hygiene problems and an increase in lameness caused by infectious agents.

Figure 16. Importance of cattle density.

Cow flow and movement

Narrow spaces and closed turns can increase traumatic injuries, especially in areas where cows congregate, such as at water troughs, feeding areas, and milking access points.

Locomotion favours foot health, and proper movements over suitable floors promotes a balanced horn-growth–wear rate (a balanced ratio of claw growth and erosion), stimulates vascularisation, and the maintenance of balanced foot shapes. However, in turn, excess displacement can cause excessive wear and injuries.

When walking, in principle, the work done by the hoof toes and heel should be balanced. This means that in cows, physiologically, there is a balance between hoof length, toe thickness, and heel height. In grazing herds and large barns with frequent milking where the animals walk a lot, this balance exists; however, we may also find animals with the correct hoof length, but with a relatively low heel height caused by the long distances they walk, and this cannot be corrected with functional trimming. In addition, toe injuries are much more frequently found in animals that walk a lot, for two reasons: their soles become thin because of excessive wear on the toes or, if the soles are a normal thickness, because of the higher pressure put on them.

When animals mostly distribute their time between standing and lying down (as is the case in most intensive small–medium-sized sheds), they spend less time walking and in movement. In these types of housed herds, the presence of injuries on the sole or white line of the abaxial zone are much more frequent, with a very low frequency of lesions in the toes. In sheds where there are excess wear problems, the incidence is usually greater in young animals. Likewise, the incidence of white line lesions in the toes, and abscesses in general, also increases.

Floor type

Whenever possible, cows always choose to walk on soft floors, whether natural or artificial. Mechanically this is important because soft floors supplement and complete the foot suspension apparatus cushioning. Prolonged use of concrete floors, which is typical for confined cows, overloads certain areas of the foot, especially in the posterior lateral hoof, and this increases the risk of the animals suffering injuries in these areas.

Very rough concrete floors cause overwear, thin soles, and severe injuries in these areas. If they are too smooth or worn down, the cows become scared to walk and this leads to slips, falls, and traumatic injuries. In grazing systems with large displacements, special care must be taken when designing the roads to ensure that the floor types are non-traumatic and have sufficient drainage.

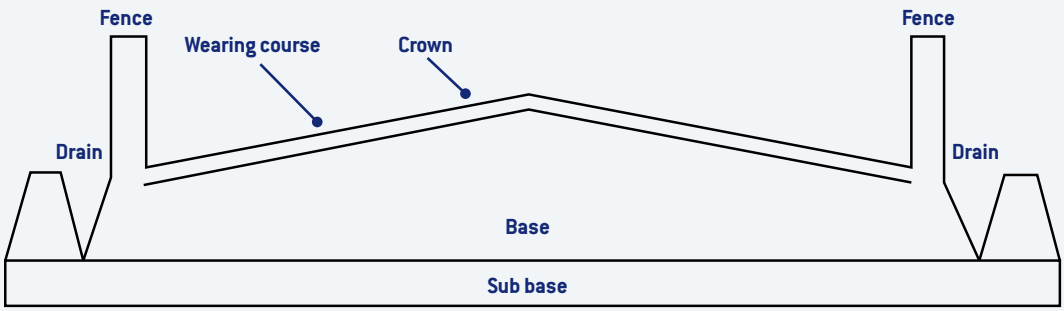


Figure 17. In pasture based system, track design is critical for hoof health.

Figure 18. Cows like walking on rubber mats.

4.2. Short term manageable factors

Hygiene

The environmental conditions of the farm must also be taken into account, in particular the humidity and hygiene of floors. Because hooves are hygroscopic, the floor dampness influences their elasticity.

Figure 19. Digital dermatitis.

This can lead to two extremes:

- Hooves that are too dry absorb less impact and this can lead to more slips.
- Very moist hooves absorb impacts, but are also softer and less resistant to objects on the ground, such as rocks. In addition, the hygiene of the environment must be taken into account when the floors are very wet.

Slurry has different effects that influence claw deterioration:

- Physical effects: hooves in continuous contact with slurry absorb moisture and this has a maceration effect.
- Chemical effects: the ammonia present in urine has a corrosive effect on the horn tissue and this facilitates the penetration of pathogens.
- Biological effects: the presence of anaerobic microorganisms can cause the appearance of infectious diseases such as digital dermatitis, and can cause heel horn erosion as well as interdigital phlemon (foul), all of which can strongly influence weight distribution.

Bedding

The cubicle beds are very important. Cows perform better in cubicles with a natural bed of straw, dry manure, or sand. It is important that cubicles with cushioned floors are soft, non-slip, and are properly maintained with a thin layer of natural bedding.

Biosecurity

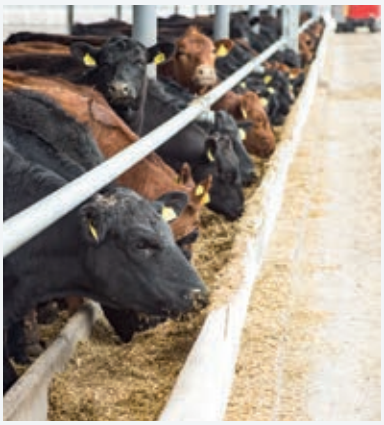
Evidence shows that the easiest way to introduce digital dermatitis into a herd is by buying infected animals. The likelihood of introducing this or other infectious diseases is much lower in closed herds.
We recommend implementing a quarantine of 15 days after the introduction of new animals, and this should include individual examination, cleaning, and hoof trimming and treatment where necessary, in addition to systematic footbathing.

Social integration

Heifers and dry cows require careful integration into the main herd after calving. Well-managed integration may prevent body-condition loss and can reduce lameness. Part of the integration process is gradual adaptation to hard floor surfaces and to the cubicle system. Cattle have a social hierarchy and introduction of heifers and dry cows creates challenges in this hierarchy: lower-ranking cows stand for longer, have reduced access to food and water, try to avoid dominant cows, and have an increased risk of suffering lameness.

Metabolism – nutrition

Not only diet, but a number of factors related to nutritional management play a key role in foot health. The correct management of the transition period is key to minimising body-condition loss, which is strongly correlated with the appearance of lameness. Sudden changes in diet can lead to outbreaks of lameness. The quality of the fibre given, its physical presentation, correct total mixed ration mixing, the quality of the feed offered, and inclusion of good-quality silage, all affect hoof horn quality.



The human factor

This influences all the other factors: the better the farmer and farm technicians' knowledge of lameness, the better the control of lameness on the farm.

- Cows must be quietly encouraged to go into the milking parlour, and this is especially important in pasture-based systems.
- The farmer's ability to diagnose lameness early and treat it as quickly as possible is key to improving the animal's prognosis. In general, farmers tend to underestimate the problem, which slows down their resolution.

Interaction of risk factors

In real cases, these factors overlap, thus increasing the risk. Inadequate nutrition can cause many more problems, especially if the cows are uncomfortable, and this is worsened with poor hygiene, resulting in complex lesions with a multifactorial aetiology.

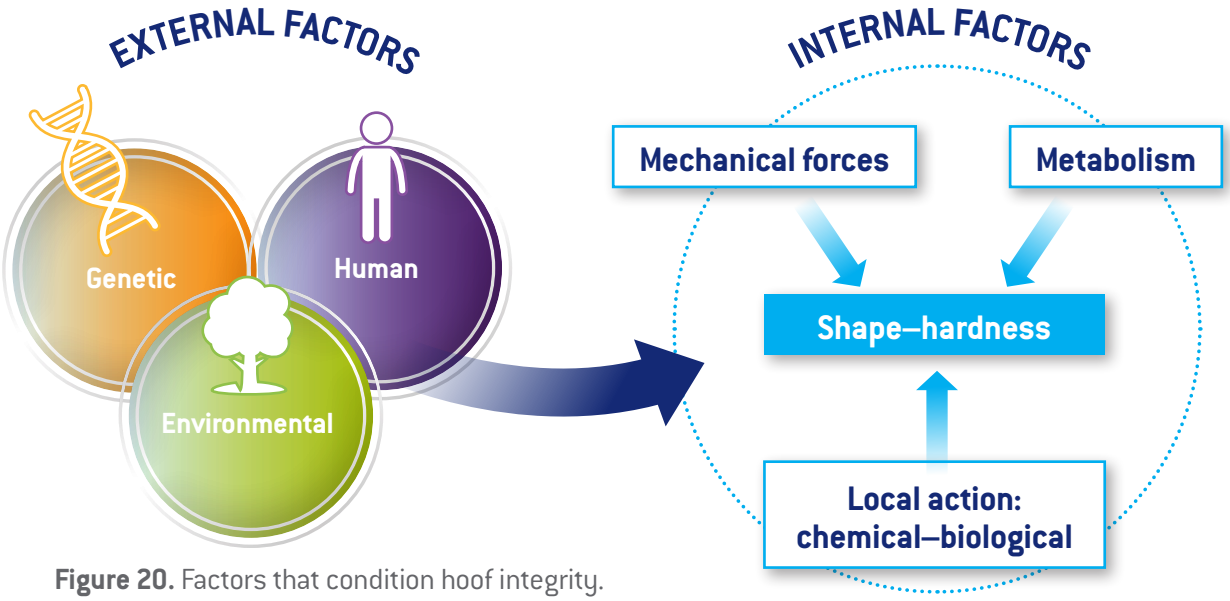


Figure 20. Factors that condition hoof integrity.

5. Diagnosis and prognosis

If we had to highlight **one fundamental factor in the fight against lameness, it would be early treatment, and this begins with early diagnosis**.

One problem we often see on farms is that cows have been treated too late, which directly influences their prognosis.

There are different ways to diagnose lameness depending on the farmer's overall objective.

Herd-level diagnostic methods

- Mobility-scoring methods.
- Hock Position Score.

Individual diagnostic method

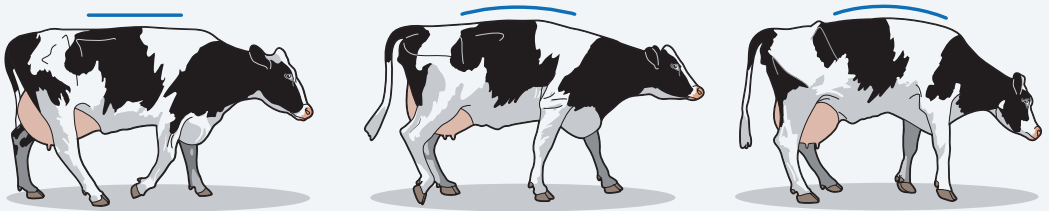
- Binary method: The clinical eye.

5.1. Herd-level diagnostic methods

The following indirect methods that are used to infer possible cases of lameness based on the postures of the cows or the way they walk.

Mobility-scoring methods

These grade the animals' locomotion into 3, 4, or 5 categories, starting from healthy to the severely lame cows, and give a general overview of the herd. For example, the Welfare Quality Assessment protocol classifies the cows as 'not lame', 'lame', or 'severely lame'.



- **Not lame:** timing of steps and weight-bearing equal on all four feet.
- **Lame:** imperfect temporal rhythm in stride creating a limp.
- **Severely lame:** strong reluctance to bear weight on one limb, or more than one limb affected.

Figure 21. Lame scoring.

The application of mobility scoring in the field takes time and requires technicians to have a very well-trained eye.

Hock position score

Cows can also be evaluated based on their position when standing. This relies on the position of the hocks.

- Cows with their hocks parallel to the body are considered healthy (1): 0º - 17º.
- Animals with an angle between the hocks of 17°–30° may be at a possible risk of injury (2).
- Those with an angle exceeding 30° probably already have lesions (3).

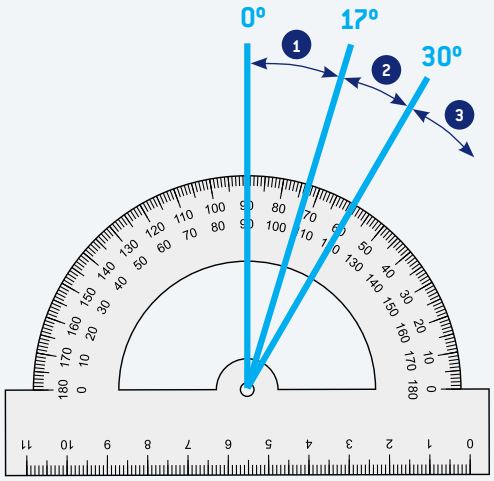


Figure 22. Measuring the angle of the hindfeet and different hocks positions: Left picture cow, has a angled hock position with a high posibility of having damage at lateral claws. Right picture cow, has well positioned parallel hocks meaning good weight balance between claws.

It is particularly significant when the angle is asymmetric: if the hock is straight on one leg (where the cow carries its weight) but is strongly angled on the other leg (where it avoids putting its weight) it is almost certain that the cow is lame in the hoof of the latter leg.
This method has the advantage that it is easy and quick to perform while cows are in the feeding line or in the milking parlour.

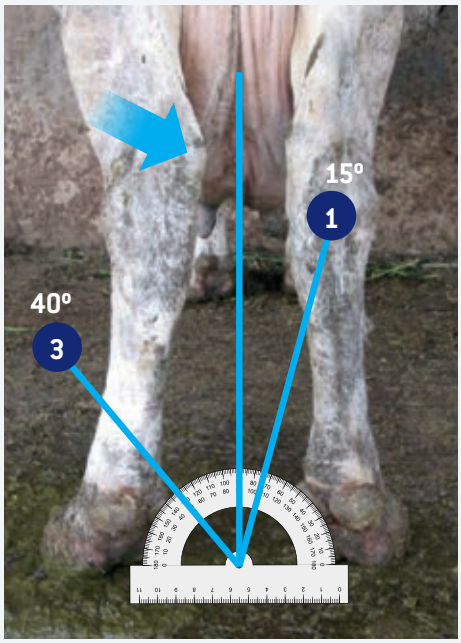


Figure 23. Bigger rotation of left side hock, probable lesion on lateral left claw.

This means that the farmer can get a global overview of the herd's status in terms of lameness, while the cows are eating and while reproductive control is performed.

Both the mobility scoring and hock position scoring are useful for consulting veterinarians and for scientific studies, allowing a benchmark to be established between stables and the evolution of the herd's foot health to be assessed over time when risk-factor interventions are made. However, they are not useful for the daily management of the herd or in the decision to treat a given cow or not.

5.2. Individual diagnostic method

Binary method: the clinical eye

The decision as to whether a cow is lame or not is made simply by watching the animal. This is based on the farmer developing a clinical eye. First it requires the producer to have a certain conviction about the importance of the problem, and second, on them then adequately training themselves to identify it on their farms. The more observant they are, the more cases they are able to diagnose.

To be effective, this method must also be linked to a rapid-action protocol. If the observer also performs the intervention, or is present when it is done, their diagnostic capacity becomes much more honed over time, so that they will eventually know not only if the cow is lame but also the lesion or disease it has. In large herds this method must be linked to strict observational protocols and worker training. According to the experience of the main author of this text, of all the tools available, this one gives the best day-to-day results against lameness in herds.

Figure 24. Note that the third cow in the row is lame in its right hindlimb.

6 Common diseases

Laminitis

Claw horn non infectious lesions

- Sole ulcer
- White line disease
- Fissures
- Thin sole
- Cork screw claw

Infectious diseases

- Interdigital dermatitis
- Digital dermatitis
- Interdigital phlemon (foot rot)

Non-foot lameness

Hock lesions

6.1. Laminitis

Also called claw horn disruption; this results from a process of inflammation in the laminar tissue underlying the dermis adjacent to the corium foot wall. In intensively managed dairy cows, this is a common subclinical presentation that becomes chronic with age. It affects several key hoof structures such as the suspensory apparatus and the digital cushion, and this predisposes the animal to the appearance of clinical lesions such as white line disease and sole ulcers. Vascular ruptures appear and cause the production of horn tissue which is soft, haemorrhagic, non-resistant, and prone to the penetration of secondary infections.

The triggers of this problem are not completely known, although they are usually multifactorial.

Figure 25. Sole hemorrhages, subacute laminitis.

- In dairy cows, the transition period is a critical period that can trigger changes. It has also been related to important body-condition changes that lead to the loss of fatty tissue in the footpads and an increased risk of injury.
- Acute and painful clinical laminitis often occurs in beef cattle, and is usually related to the use of overly unbalanced diets that are rapidly metabolized.

Figure 26. Acute laminitis in beef cattle, notice pain on 4 limbs.

6.2. Claw horn non infectious lesions

Sole ulcer

This is an **aseptic pododermatitis limited to the pressure zone of the plantar tuberosity of the third phalange** that, under conditions of excessive pressure, damages the underlying dermis. This first produces a haemorrhage, and in clinical cases, then becomes ulcerated and results in frequent herniations of the corium. This excess pressure is produced by prolonged standing or by alterations of the structure of the hoof, laminitis, severe heel erosion, or unequal lateral and medial claw sizes (imbalance).

Figure 27. Sole ulcer.

White line disease

Because the area of **the white line between the hoof wall and the sole is weaker, it can easily be damaged, producing the continuous penetration of anaerobic bacteria that cause secondary** infections. These can form abscesses extending over the surface of the sole, through the laminar zone of the wall of the corium and reaching into the coronary band.

The severity and prognosis of these abscesses depends, above all, on the timing of treatment, the environment, and the location of the lesion—the closer it is to the toe, the more painful they are and faster they develop. This is because there is no suspensory system at the toe tips and each stride is driven from this zone.

Figure 28 & 29. White line disease.

White line problems at the toe tips are more frequent in cows that walk a lot and among those with thin soles. In more sedentary cows, most white line lesions are located in abaxial areas, closer to the heel. It is less frequent to find abscesses in the axial zone where the white line ends. Metabolic factors linked to mechanical causes and comfort may be the origin of these problems.

Fissures

Vertical fissures are most frequent in beef cattle put out to pasture. **This may be related to the loss of the horn quality resulting in horn tissue drying, as well as possible mineral deficiencies.** Septic cracks may appear in dairy cattle as a result of the drainage of digital dermatitis injuries into the coronary band. Horizontal cracks can also be observed and are caused by the sudden interruption of coronal tissue production at the level of the coronary band. This may be related to systemic septic processes such as some types of mastitis and as a possible reaction to the foot-and-mouth disease vaccine.

Figure 30. Horizontal crack.

Thin sole

The sole should be at least 5 mm thick to ensure sufficient protection of the underlying sensitive tissues. Thin soles are a consequence of an **imbalance in the production–wear binomial, favouring the latter.** This happens when the animals must walk along very long routes or on abrasive floors. In these conditions soft hooves, either because of a high moisture content or poor hoof quality, wear down more quickly.

Problems with thin soles occur both in extensive grazing systems and in large herds with frequent milking. This problem should be carefully monitored on farms with permanent housing and sand beds.

A common mistake in the construction of new sheds is the installation of very rough cement floors to prevent cows from slipping. However, these can also cause problems with thin soles. In intensive herds where cows walk a lot, the use of rubber mats in transit areas can reduce sole wear.

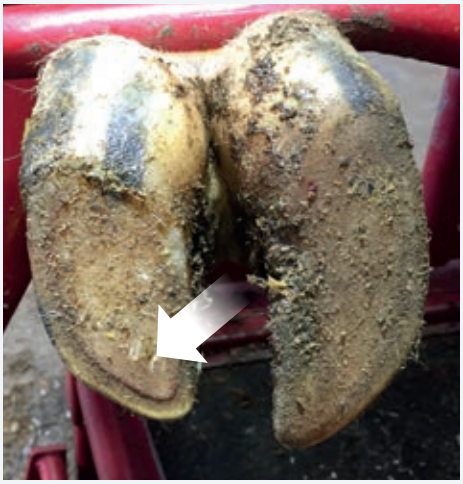


Figure 31. Thin sole (Notice claw is very short, sole is detached at white line level).

Cork screw claw

This is a congenital hereditary problem. **The hoof is twisted on its horizontal axis and thus, the hoof wall curves inwards and occupies the space of the sole.** The internal position of the phalanges is also altered.

Treatment requires frequent functional trimming to slow down the deformation. Prevention implies not preserving the genome of affected cows as future reproductive animals.

Figure 32 & 33. Cork screw claw.

6.3. Infectious diseases

Interdigital dermatitis

This is primarily an exudative erosion of the skin of the interdigital space, which evolves into chronic forms with heel erosion, abnormal hoof growth, imbalances in the growth of the lateral and medial claws, and interdigital hyperplasia.

It does not always cause obvious lameness, but the animals tend to become restless during milking and frequently change their weight from one limb to another. Interdigital dermatitis affects the hindhooves much more than the forehooves. Although it does not cause obvious lameness, this disease is endemic in stables with poor hygiene where there are many affected animals. Chronic irritation stimulates horn overproduction and causes the lateral claw to grow over the medial claw.

Figure 34: Interdigital dermatitis and heel erosion.

In herds affected with chronic interdigital dermatitis, the animal's hooves must be trimmed frequently in order to balance the weight between them, eliminate heel horn erosion, and relieve weight from the area usually affected by sole ulcers; chronic heel erosion may be related to the increased occurrence of sole ulcers. In addition, it is common to find cows affected both by chronic interdigital dermatitis and chronic laminitis, and these animals require very frequent hoof trimming.

Digital dermatitis

This is an inflammatory ulcerative skin erosion with a strawberry-like skin appearance and abnormal hair growth at its margins. It typically occurs around the heel bulbs, although it can also appear in the interdigital space, dorsal border of the coronary band, or under the accessory digits.

Infection with a mix of bacteria, including treponema that attack skin that is macerated by the chemical effects of slurry. The acute stages can evolve to become chronic, and this is associated with heel erosion.

There are several stages:

Healthy animal

M0

Small subclinical lesion, less than 2 cm in diameter, that only appears to be painful when put under pressure.

M1

Acute and painful active ulceration; size is somewhat larger than in M1 stage, is bright red, and has a granulomatous appearance.

M2

Lesion in the process of healing after the application of a topical treatment; a few days later a non-painful scab appears, which can remain until the wound is completely cured under favourable conditions, or the injury may evolve towards a chronic lesion.

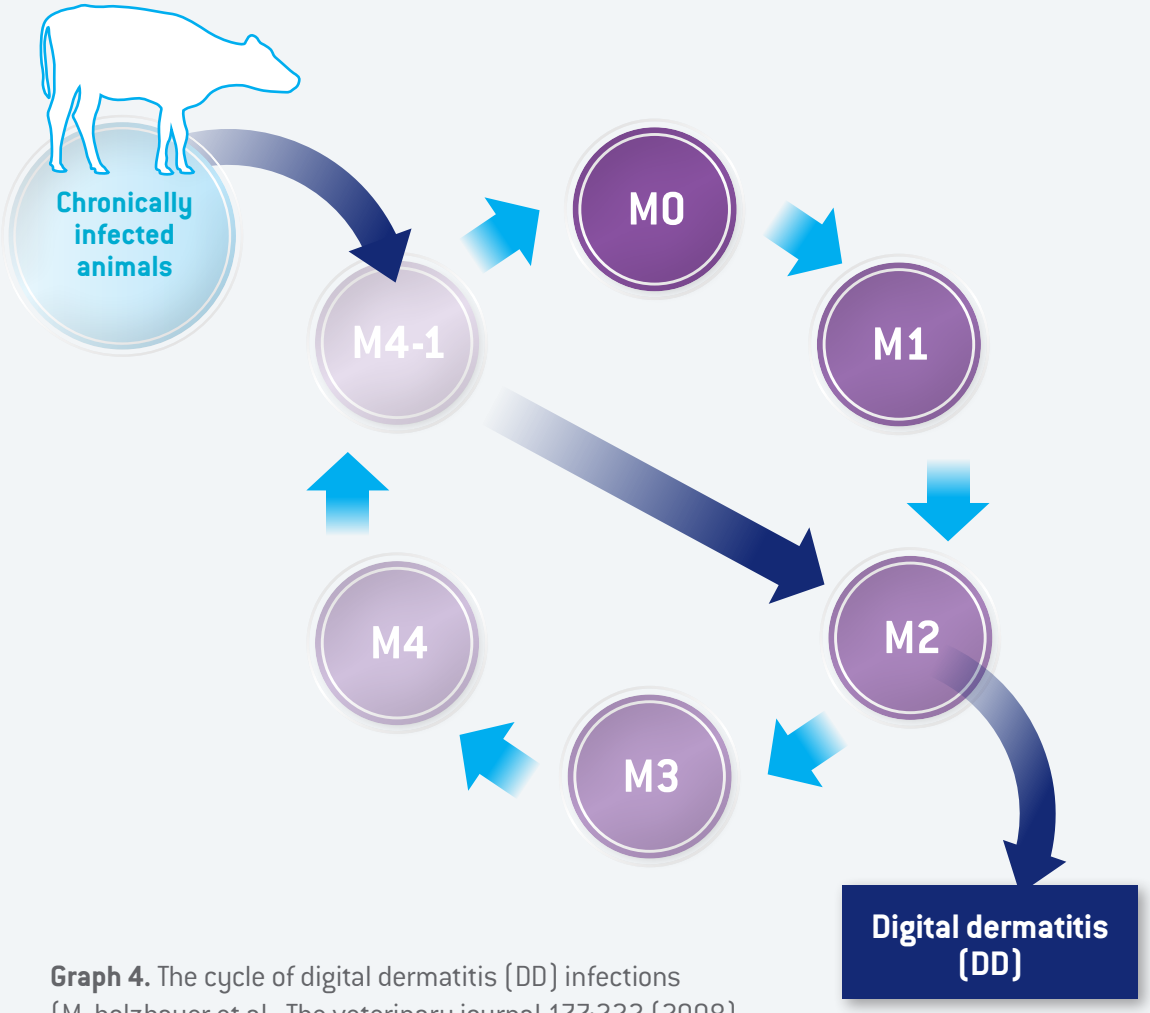
M3

Chronic, hyperkeratotic, wart-like lesion which may even have filamentous proliferations from which the common name of 'hairy warts' is derived.

M4

Chronically affected foot that displays the M4 stage in addition to the M1 stage.

M4-1



Graph 4. The cycle of digital dermatitis (DD) infections (M. holzhauer et al., The veterinary journal 177:222 (2008).

It is common to find several wounds at different stages on the same hoof. Every treatment has to be started by hoof trimming, and all the stages of digital dermatitis lesions become visible during this process. Hoof trimming is important for digital dermatitis treatment and management both in individuals and at the herd level in order to prevent outbreaks.

Treatment can reduce the clinical signs of digital dermatitis, although it is unlikely that all the bacteria responsible for this disease can be eradicated. For the treatment to be successful, it is likely that it will need to be combined with footbaths.

Interdigital phlemon (foot rot)

This is an acute, **deep infection of the subcutaneous interdigital space tissue caused by the penetration of anaerobic Dichelobacter and Fusobacterium bacteria through interdigital skin erosions or by the penetration of foreign bodies, stones, straw, etc. It is also known as 'foot rot'.** The disease evolution is very fast and causes a sudden drop in production and a decrease in food consumption. The treatment consists of systemic antibiotic therapy, and early detection and treatment is key.

Complications affecting adjacent tissues can quickly appear, and their prognosis is much worse. This disease starts with sudden and obvious asymmetric inflammation and hoof separation; within a maximum of three days the interdigital skin ruptures and proliferation tissue forms. If the disease if treated within the first few hours the results are usually very good, but the prognosis worsens as time passes.

Figure 35, 36 & 37: Interdigital phlegmon.

Figure 38: A typical, and very painful and disabling complication with a poor prognosis is septic arthritis of the distal interphalangeal joint. In these cases, the treatment of choice is amputation of the affected digit.

6.4. Non-foot lameness

Lameness higher up the leg often originates from a trauma and there are usually few options for intervention, non steroidal anti-inflammatory drugs (NSAIDs) can be applied to treat pain and inflammation. The evolution of the lesion will determine the animal's prognosis. The most frequent causes are slippery floors, narrow passages on farms, contact with sharp objects, and hurried handling of cattle.

6.5. Hock lesions

Provision of inadequate beds and poor cubicle maintenance are the main causes of hock abrasions. **These abrasions can become disabling and may evolve into inflammatory processes at the lateral level of the hock, which can become infected, and cause bursitis or even arthritis in the most severe cases.**

Not lame			Lame
No Swelling. No hair is missing, some hair loss or broken hair.	No Swelling or Minor Swelling(<1cm). Bald area on hock.	Medium Swelling (1-2.5 cm) and/or lesion on bald area.	Major Swelling (>2.5 cm). May have bald area/lesion.

Figure 39: Hock condition score.

7. Treatment and prevention

7.1. Restraint and tools

Restraint

It is essential to work under safe conditions.

Kinds of restraint:

Manual Restraint

Mechanical Restraint

- Dutch-style 'cow crush'
- 'Calf' or 'cradle' table
- 'Stand up crush double belly band'

Manual Restraint

The hindlimbs can be raised with the help of a rope by making a sliding knot with a loop or a tourniquet using a stick placed just above the hock. Thus, the cow maintains four points of support and the operators do not have to overexert themselves.

The hock must be raised to the height of the coxal bone. It is important that the sliding knot is strong and flexible to avoid injuries, but that it holds the extremity well. The animal must be tied up. This type of fixation is useful for isolated individual cases, and although very little material is required, the work is dangerous and difficult. The use of anaesthesia is essential for painful treatments.

Bulls and strong animals can be immobilised with the help of anaesthetic techniques or by tying them with several loops and ropes.

Figure 40: Manual restraint with rope.

Mechanical Restraint

DUTCH-STYLE 'COW CRUSH'

These are usually manual or electric machines, although there are also models equipped with other technologies. Cows are secured with a single strap across their chest and one limb is raised at a time; the hindlegs are lifted with a strap above the hocks. This technique requires more knowledge and experience.

Figure 41: Dutch-style 'cow crush'

TILT TABLE OR TRIP OVER CRUSH

These have a simple construction. If animals are kept in them for prolonged periods there is danger of paresis caused by compression of the brachial plexus. These tables make working with the hooves and keeping them straight cumbersome, and because the hooves are not very restrained, great skill is required to be able to trim.

Figure 42: Restraint on a Tilt table.

'STAND UP CRUSH DOUBLE BELLY BAND'

This type of machine is very widely used by professionals. They also make it possible to simultaneously immobilise all four limbs because the cow is fixed and lifted with two ventral straps. The hooves are very strongly restrained, making the work easier and safer. Because the cow is more strongly contained it becomes less stressed.

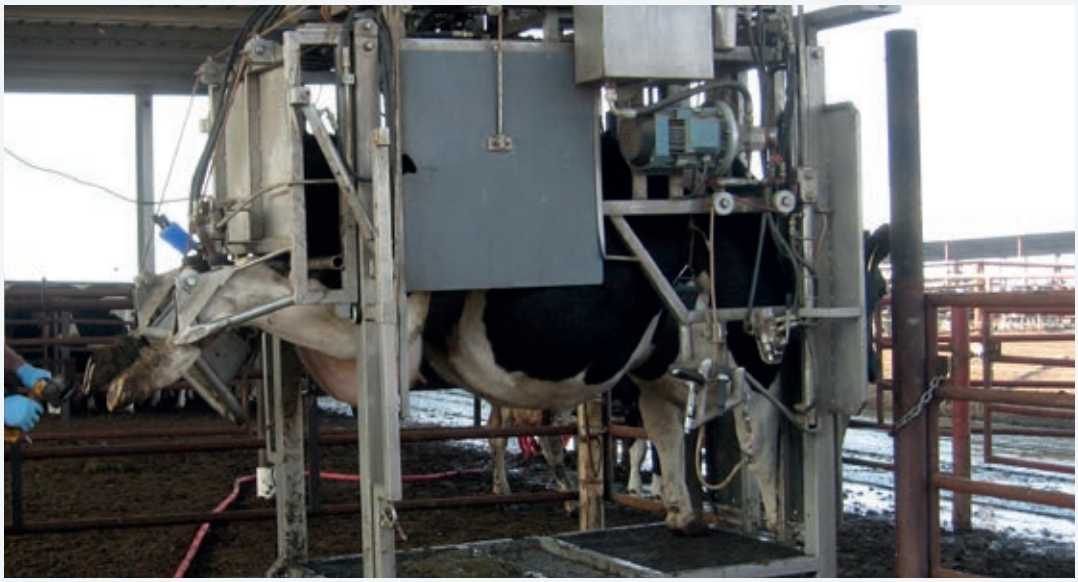
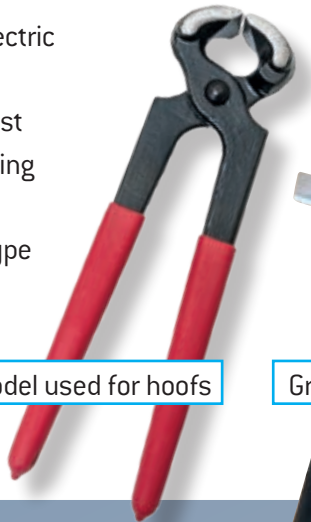


Figure 43: Restraint using a double belly band fully automatic crush.

Trimming tools

The basic tools for trimming hooves are **hoof knives and pincers**, and it is important to always work with sharp hoof knives. The use of electric grinders and specific trimming discs is becoming more widespread because they are faster and more comfortable and easier for the operator. The use of electric tools is not recommended with manual restraint.
There are several types of trimming discs, the simplest are abrasive, but the most professional ones are cutting blades that work faster and leave a cleaner surface.
The type of trimming disc should be adapted to the type of restraint and the operator's experience.

Left and right narrow blade hoof knife



Pincer model used for hoofs

Grinder

Figure 44, 45 & 46: Trimming tools.

Sharpening:

To achieve the best results when trimming hooves, very sharp tools should be used.

Tools can be sharpened by hand with a file or by using a specific electric machine.

7.2. Functional trimming

This is a rationalised method based on physiopathology for use on large-scale operations. The most universally-recognised protocol is known as the Dutch index method, which is based on geometry and aims to obtain the ideal hoof proportions. It establishes a link between the length of the dorsal hoof wall and the thickness of the sole in the apical area: the longer the hoof, the thicker the sole at the toe tip. However, although one can work with a didactic protocol as a guide, it is important to remain flexible and also consider geographical, breed, and individual variations.

An average hoof length of 7.5 cm has been established for Dutch Friesian cows, but this length is only indicative and therefore, experience and prudence are required to avoid excessive trimming. One must consider that the size of the hooves depends on the animal's age and breed. The Holstein Frisian breed has become the most common breed on intensive dairy farms. These are significantly larger than the Dutch Friesians with whom the method was first developed in the 1980s, and so that their hooves are also larger. Therefore, recent studies recommended an updated 'normal' hoof length of 9 cm for Holsteins.

Subsequently, other authors have proposed variants to this method. For instance, Blowey proposes relying on the appearance of the white line as a way of estimating the thickness of the sole at the toe tip. All of these methods are quite similar and have a functional logic, but the final result of the trimming will depend on the style and experience of each operator. There is currently no scientific evidence that reliably proves the superiority of one method over another.

What are the feet of housed cattle like?

The flat surface of the sole changes. Stabled animals require a flat sole because the ground does not cushion their feet as it would in conditions of freedom. There is also a decompensation in the relationship between hoof growth and wear, where there is usually more growth than wear. This difference is more striking at the toe tip, where the hoof is harder and takes longer to wear down, and in the heel area, where the hoof is softer and more flexible and so it wears down faster. The combination of these alterations results in the elongation of the hoof and loss of height in the heels, and consequently, loss of the anatomical angle, and this tends to affect the lateral claws of the hindlegs and medial claws of the forelegs most.

Each individual animal needs different attention, and therefore their needs must be decided upon before starting trimming. For most intensive production cows, preventive trimming once or twice a year is beneficial, however, others may never need hoof trimming. Animals that have suffered some type of disease in their hooves (especially a chronic disease), or which have deformations, usually require more attention.

The rationale of functional trimming

Its intention is to restore the morphology of hooves—based on their anatomical, physiological, and biomechanical needs—which have become deformed because of the animal's accomodation conditions.

For trimmers with little experience, it is very useful to follow the routine trimming guidelines, thus always avoiding hurting the animal. The general guidelines explained below are applicable to the Holstein Friesian breed, however, the trimming must be modified according to the breed and the age of the animal.

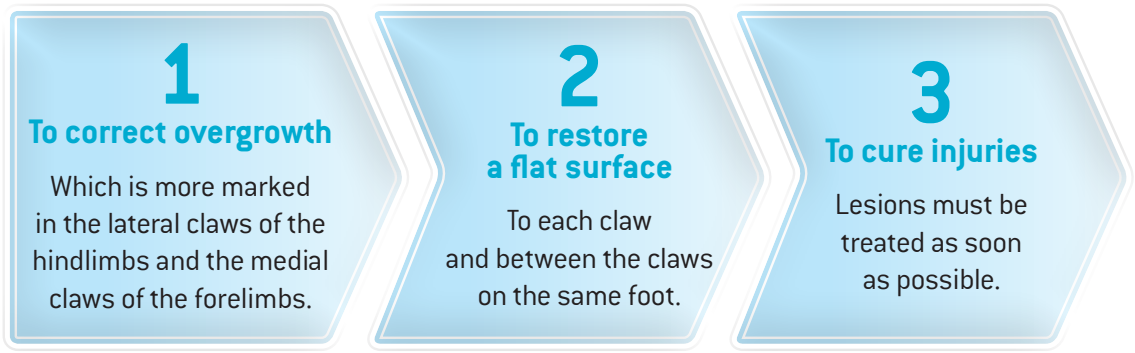


Figure 47: Functional trimming.

Trimming protocol	STEP 0 Preliminary examination and study of the animal's history	
HINDLEGS	STEP 1 Trim medial claw	STEP 3 Mark the axial gaps STEP 4 If an injury appears, cut back the diseased claw heel STEP 5 Clear away the heel erosion
	STEP 2 Trim the lateral claw	
FORELEGS	STEP 1 Trim the lateral claw	
	STEP 2 Trim medial claw	

Table 2: Trimming protocol steps.

STEP 0 Preliminary examination and study of the animal's history

Before starting to trim, it is advisable to visually examine the animal and perform a brief anamnesis. One should consider general aspects such as the animal's body condition, appearance, and hygiene of the legs. Special attention should be paid to the claws, the appearance and growth of the hoof wall, its alignment, and the animal's posture while walking.

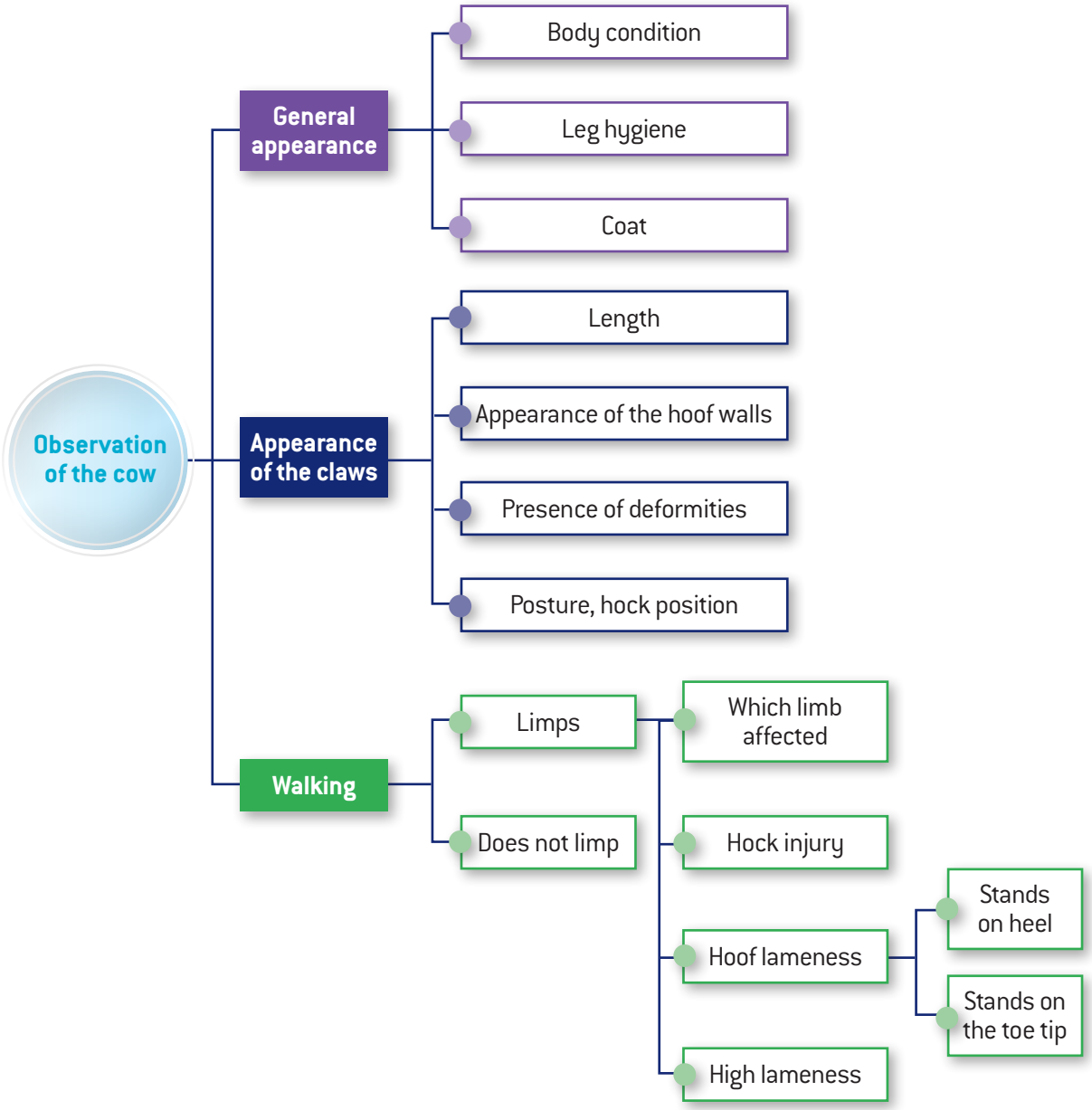


Figure 48: Preliminary observation and examination of the animal.

Functional trimming work protocol

When in doubt, it is always better to remove less than more: a limp caused by trimming can have dramatic consequences.

HINDLEGS

STEP 1 Trim the medial claw

Figure 49: Medial claw trimming.

Begin with the medial claw because it is normally the least affected by mechanical deformations and/or diseases.

- The length (from the coronary zone to the toe tip) of the claw of a regular cow is at least 7.5 cm; any horn that exceeds this measurement should be cut. Important warning: This length can vary depending on size of animal
- With a minimum length of 7.5 cm, the thickness of the sole should be about 0.5 cm. The excess thickness of the toe tip is eliminated (lowering the sole) but this must be done also respecting the height of the heel. In cases in which the dorsal wall is curved inwards, part of the dorsal wall can be removed in order to straighten it and better assess the real thickness of the tip.
- The cut is made following a plane perpendicular to the axis of the leg in order to obtain a stable tread on smooth concrete floors. The surface of the sole must be flat.
- The heel remains untouched.

STEP 2 Trim the lateral claw

Using the medial hoof as a reference, cut the lateral claw to the same length and thickness. Trim the surface of the flat sole and lower the height of the lateral heel until it reaches that of the medial heel. The heels should measure approximately half the dorsal length of the claw, i.e., 3.5–4 cm.

Figure 50: Lateral claw trimming.

FORELEGS

Although the hooves of the forelimbs adopt abnormal forms, lameness is less frequent in these than in the hindlimbs. When lameness does occur, it almost always appears in the medial claw.

STEP 1 Trim the lateral claw

- The lateral claw is usually more normal in the forelimbs. Cut it to a length of 9 cm with a toe tip thickness of 0.5 cm.
- The hoof growth tends to lead to the development of a higher heel height to the detriment of the tip, and so trimming often involves reducing the heel height to the level of the medial hoof, respecting the thickness of the toe tip.

STEP 2 Trim the medial claw

- Trim it so that its length and thickness is equal to the lateral hoof.
- This usually requires lowering the sole a lot, and often also lowering the heel a little to balance it with the lateral claw.
- The medial hoof tends to bend at the tip and strike axially against the lateral one. Thus, the surplus horn at the tip must be removed axially.

The remaining steps for trimming are the same as for the hindlimbs.

Functional trimming is actually a skill: practice makes perfect. You have to assume that mistakes are inevitable, and they should not be ignored.

HINDLEGS AND FORELEGS

STEP 3 Mould the axial gaps

- Mould wide and deep hollows into the axial zone of the sole with a special emphasis on the lateral hoof. The depth and extension of this moulding will depend on the type of hoof and its morphology. Recent studies show the importance of carving a wide axial gap at a distance of 1,5 cm to the abaxial wall.
- Avoid direct contact of the flexor tuberosity of the third phalanx to help prevent the appearance of sole ulcers.
- It is important to respect the area of the toe tip when marking the axial gaps, so as not to destabilise the animal's balance or expose the third phalanx too much.

Figure 51: Mould the axial gaps.

STEP 4 Lower the heel on the diseased hoof

- If signs of disease appear in a claw (usually the lateral one) during the trimming, the height of the heel is lowered to send weight to the healthy hoof.
- The first third of the heel is left alone. The signs that most frequently lead to step 4 are the appearance of white line separation or sole haemorrhages.

STEP 5 Clear the heel erosion

- When there is detached horn tissue on the heels, it must be removed.
- This reduces bacterial proliferation and facilitates air circulation and contact with the footbath disinfectant. This is very important in farms which are frequently affected by dermatitis.

The most frequent trimming technique mistakes

- **Cutting the back wall too much,** so that the dorsal length of the claw ends up being less than 7.5 cm.
- **Removing horn in the heel area of the hindlimb medial claws.**
  Excess trimming decreases the dorsal angle of the hoof, increasing the chances of trauma to the external hoof.
- **Removing the axial wall at the toe tip of the hoof.**
  This leaves a zone which is very important to maintaining equilibrium very exposed.
  This is only recommended for anterior limbs with a very overgrown medial hoof; in these cases you can remove some horn, but only in the deformed (medial) claw.
- **The trimming leaves a concave sole,** with the axial zone more trimmed than the abaxial one. Animals in housing with concrete floors should have flat soles.
- **Insufficient emphasis** is put on moulding the axial hollows in the posterior lateral claw: when there are obvious signs such as sole haemorrhages and heel erosion, an axial hole should be moulded as deep and far into the hoof as possible without damaging it. This task is often underestimated, especially in maintenance work with power tools.
- **Removal of the hoof side and back wall.**
  This error is quite frequent because of client demands, who often think more about aesthetics than functionality. The hoof wall supports much of the weight and is also the area that protects the chorion; if we eliminate it, we reduce the weight-support surface and leave the chorion more exposed.
- **Excessive thinning of the soles.**
  After the trimming, the sole should not yield to pressure put on it with a thumb or by a curette. If it yields to this type of pressure it is indicative that we have left the sole too thin these cows will soon be lame. The area most sensitive to this error is the tip of the sole, because of its function in the sequence of each stride in cows.

7.3. Therapeutic trimming

After having completed the 5 previous steps, the horn tissue around the lesion is then eliminated.

It follows the principles of functional trimming and aims to:

- **Relieve pressure** on the diseased hoof by functional trimming and by placing a hoof block on the healthy hoof.
- **Open the lesion** by removing the diseased tissue while avoiding doing damage to the healthy tissue.
- **Create open areas** which can more easily heal.
- **Facilitate drainage.**
- The work can be started with an electric or manual machine. Once close to the lesion, **remove the horn tissue** with a sharp hoof knife.
- **Avoid damaging the live tissue.**
- **Make sure there are no cavities** with damaged tissue that could cause a recurrence.
- **Apply the treatment that best suits the injury:** an orthopaedic block, topical treatment, NSAID and/or antibiotic.

Figure 52: Placement of hoof block.

It is better to start with the affected claw. When we work on the diseased limb, we must also pay attention to the healthy claw. The affected claw is usually oversized, which causes the animal to carry even more weight on it. If we carefully trim the healthy claw the distribution of weights can be changed to reduce the work the diseased claw must do while it heals. It is also useful to trim the other hoof because the cow will be carrying more weight on it. Use of block at healthy claw is highly recommended to relieve pain and improve recovery.

Periodic reviews of severe and/or chronic cases are recommended. If lameness appears or becomes worse after trimming, the affected hooves should be checked more carefully. You should always avoid damaging the healthy corium.

Most of hoof interventions are considered minor surgery and, when performed correctly by trained personnel and with the proper instruments, should be minimally painful to the cow.

The use of systemic NSAIDs as a pain management strategy should always be considered. In complicated cases, a local anaesthetic should be used.

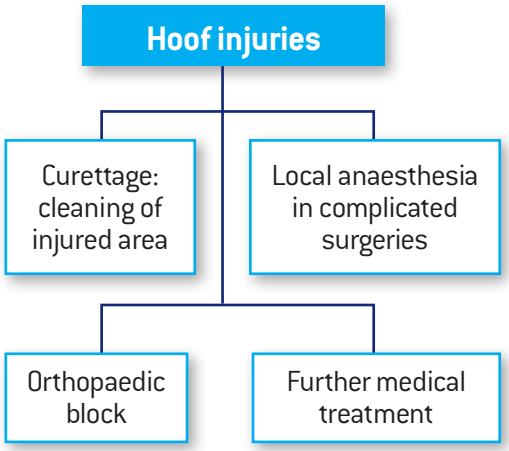


Figure 53: Strategy for hoof injuries.

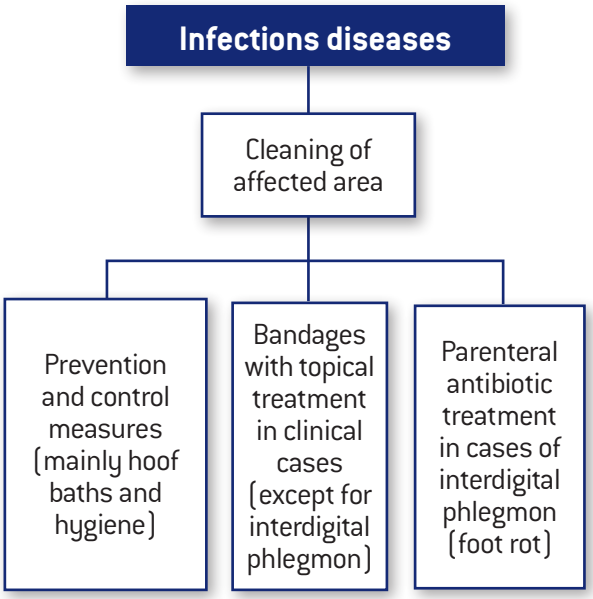


Figure 54: Strategy for infections diseases.

7.4. Systemic and topical treatment, antibiotics, and NSAIDs

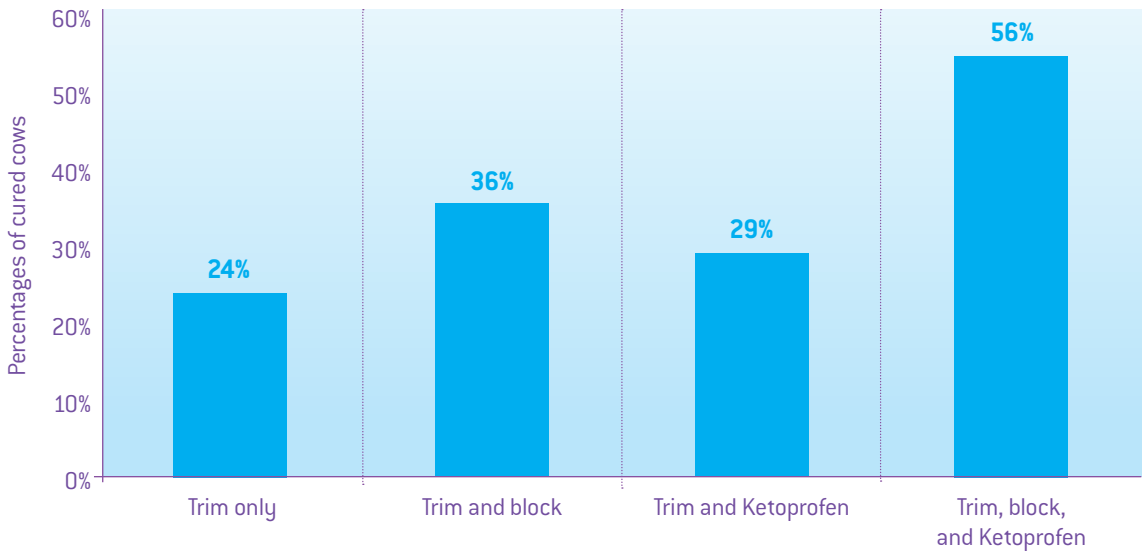
Systemic treatment

Anti-inflammatories:

Recent studies suggest that **the application of NSAIDs** as a complementary support to the common practices of functional trimming and the application of orthopaedic heel blocks, in case of non infectious hoof diseases such as ulcers and abscesses **favours the prognosis of treated cows five weeks after the treatment is administered.**

The use of NSAIDS as a palliative to pain, especially in the first days after treatment, should also be considered from an animal-welfare point-of-view.

The addition of a block to the non-diseased claw has a definite benefit and this effect is enhanced further when NSAIDs are also used; after 5 weeks the following percentages of cows were cured:



Graph 5: Percentage of cured cows depending on different treatment strategies (Thomas et al, 2015).

Antibiotics:

As a rule of thumb, support treatments for interdigital phlegmon (foot rot), such as therapeutic trimming, **should be used every time swelling is found.**

Topical Treatment

- Topical treatment is preferred after functional trimming in cases of digital and interdigital dermatitis: **Tetracycline spray:** Topical tetracyclines are a widely-used and there is good scientific evidence for the efficacy of the topical use of these broad-spectrum bacteriostatic antibiotics.
- **Salicylic acid:** Salicylic acid has been traditionally used for hyperkeratotic skin diseases and its efficacy in treating digital dermatitis is well established; its highly keratolytic formulations are recommended.

Bandaging

Results suggest that bandaging accelerated the healing of digital dermatitis lesions, regardless of treatment type, and that these lesions were significantly less likely to develop into stage M4, the chronic stage of digital dermatitis. Covering digital dermatitis lesions is advantageous to both the wound healing process and the cow's wellbeing.

There are not many well-founded studies about the usefulness of applying bandages in cases of sole ulcers or abscesses. Our personal experience suggests that early diagnosis and treatment by therapeutic trimming and application of an orthopaedic block is usually sufficient to achieve good healing. However, it is common to find lesions resulting from abscesses caused by white line disease and sole ulcers that do not heal, and these are also sometimes affected by digital dermatitis.

In more advanced lesions affecting more extensive or sensitive areas, the application of a topical treatment and bandage protection can help both the healing and the welfare of the cow by avoiding friction with the open wounds when the cow lays down. If bandages are applied, the treatment must be followed-up by removing the bandage and, where necessary, its replacement to avoid iatrogenic anaerobic sepsis.

Bandages should only be applied if a follow-up can be guaranteed, or at the minimum, if we know that the bandage will definitely be removed within a reasonable period, between three and ten days depending on the injury and the environment. In certain environments, for instance on farms that use water-jet cleaning or flushing, it cannot be guaranteed that the tissue will remain dry; in these cases, it is not viable to bandage injuries for more than 3 days.

	BANDAGE	
Recent lesions	NO	
Chronical lesions	Italy, Germany YES	Holland, USA NO
Dermatitis	YES	
Interdigital phlegmon	NO	

Table 3: Bandage recommendations.

7.5. Prevention

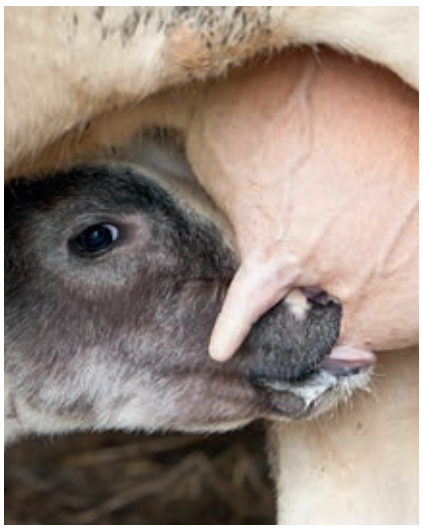
The first action of a foot health program is to create a protocol for the early detection and treatment of lame cows. By addressing the lack of detection, lameness prevalence can drop dramatically.

The working strategy for dealing with a problem of lameness in a farm should follow this order:

1. **Establishment of a functional trimming protocol for the early detection and treatment of new cases that is adapted to the needs of the farm**
2. **Implement a footbath program**
3. **Analyse the risk factors and establish the priorities for improvement**
4. **Minimise metabolic stress**

The most important part of the foot health program is to create a protocol for the early detection and treatment of lame cows. By implementing this, it is likely that the dairy industry can contribute the biggest reductions in the prevalence of lameness by addressing the lack of detection and treatment of the problem.

The transition period is a time of great metabolic stress. If cows stand for too long during this time, foot problems, as well as other metabolic diseases, can increase. Ensuring that they have a stress-free calving decreases chances of getting lame during the whole lactation.



Recent studies show that **there is a relationship between the body-condition score, thickness of the digital cushion, and lameness rates**. These findings suggest that cows that lose a lot of body condition during early lactation also lose a lot of their capacity to absorb shock through their feet fat cushioning system, thus increasing their risk of lameness. Traditionally, nutritional factors and herd

nutritionists have received a lot of the blame for lameness problems in herds. But the evidence in the literature for a causal relationship between subclinical acidosis and lameness is very weak. The way cows eat is more important than the diet on the paper. Many factors affect the way cows eat as can be food availability, overcrowding of bunk leading to sluggish feeding or quality of feedstocks.

To minimise metabolic stress and to promote proper horn growth and integrity the role of trace minerals and vitamins in a foot health program cannot be ignored.

Footbaths

The systematic use of footbaths became necessary in most dairy cow facilities in order to effectively control dermatitis. These are maximally efficient when combined with other measures for comfort and hygiene.

The following factors must be considered:

1. **Placement**

   The bath is usually placed at the exit of the milking room at a sufficient distance so that it does not obstruct the flow of the animals and does not emit fumes that could affect the milking technicians.

2. **Design**

   Ensure that the cow passes through it with all 4 feet, that it is of a minimum width, and that the container walls prevent splashing in order to retain the product.

3. **Disinfectant**

   Make sure that it has a reasonable cost-efficiency ratio and that it is the least harmful possible to the workers and animals. The most popular products are copper sulphate, although this presents problems of environmental pollution caused by its accumulation in the soil, and formalin which emits vapours and is considered a carcinogen and so its use should be avoided or reserved for very specific situations and should be used with extreme caution in very ventilated areas.

4. **Dosage**

   For this it is important to know the real capacity of the footbath; it is better to use a lower dose and increase the bathing frequency. Both copper sulfate and formaldehyde are usually used in a 5% solution.

5. Frequency

The footbath should be used as a preventive and so a routine that changes in each barn, and in which its frequency of use varies from once a week to every day, should be followed.

6. Renewal

This will also depend on how the hooves are cleaned upon entering the stable, but the bath is tipically changed every 300 cows.

7. Temperature

This mainly affects formalin; at temperatures below 10°C formalin is inactivated and at high temperatures it can cause burns (in this case the dose should be lowered). Where it is affordable, automatic footbaths that are programmed are ideal and produce excellent results.

The current recommendations are:

A footbath measuring 3 m long, 0.50 m wide, with a fluid depth of 0.15 m, along with footbath content replaced at a maximum of 200–300 cow passes. On farms with a high digital dermatitis prevalence, implementation of proper footbath design and improvement of footbathing management will decrease the prevalence of active digital dermatitis lesions and increase the prevalence of healthy animals. In addition, improving cow cleanliness will further help to control active digital dermatitis lesions.

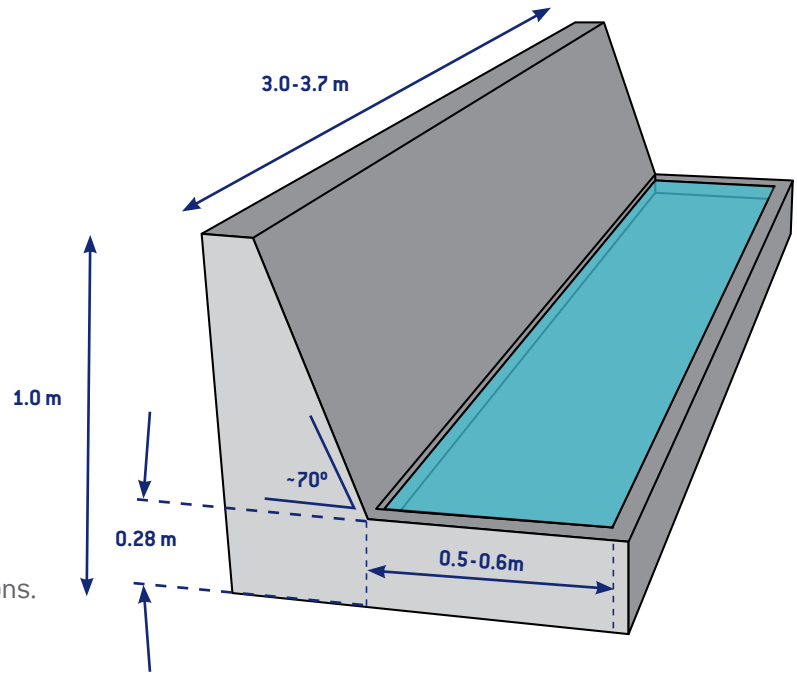


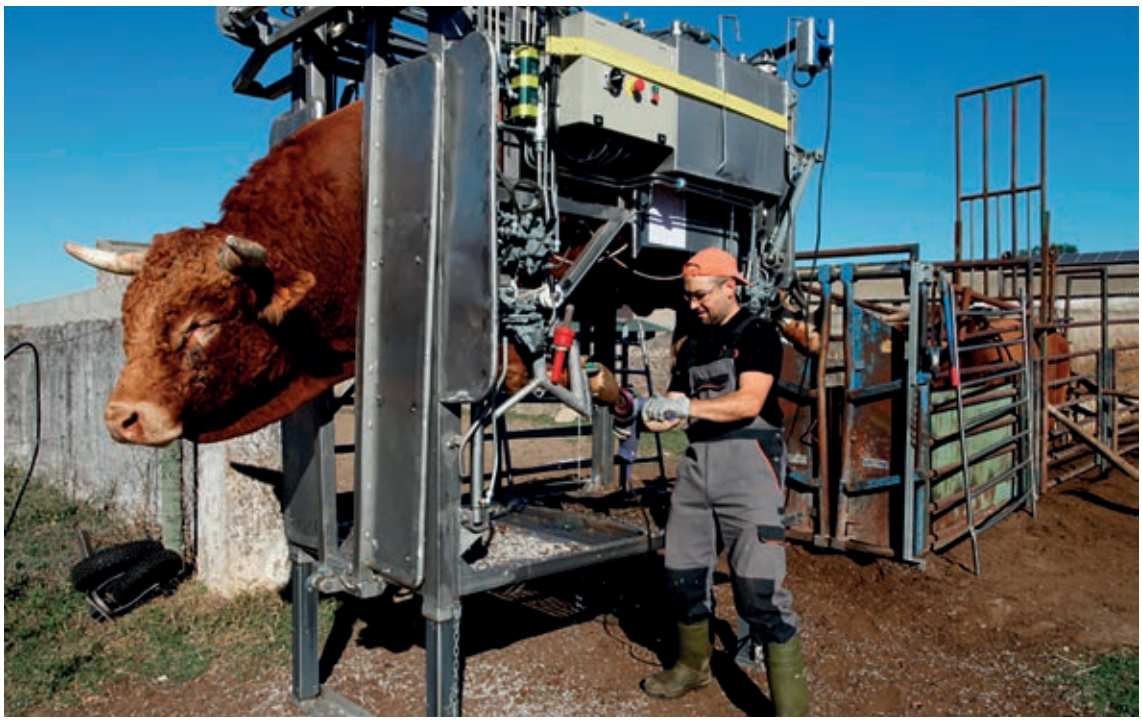
Figure 55: Footbath dimensions.

8. Conclusions

Perhaps because of the problems associated with the difficulty of accessing animal feet, lameness is a neglected issue which is worryingly common, both from the point of view of animal welfare and in terms of the reduction in productivity that it entails. Diagnostic protocols and early treatment should be established as the quickest way to minimise the effect of lameness.
This requires restraint equipment and adequate material, as well as the presence of trained clinical and facility technicians.

Short, medium, and long-term action programs should be established to carry out specific controls on the hooves of stock animals, which should focus on the early treatment of lame cows, preventive functional trimming, and regular use of footbaths, as well as general management measures to ensure cow comfort, hygiene, and good nutrition.

By focussing on lameness, the dairy industry can prevent this problem from becoming a major animal welfare issue. The implementation of this knowledge requires a dedicated management approach to foot health, similar to the one used for udder health. The key to this program is to detect and treat lame cows early, focus on clean, dry and comfortable feet that are regularly disinfected and evaluated, and ensure that cows do not experience metabolic stresses at key periods in their lactation. These efforts should be coordinated among farmers, veterinarians, hoof trimmers, nutritionists, and contractors in order to achieve results.



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