"On Track" The treatment and prevention of lameness in dairy cattle

A guidebook commissioned by GippsDairy

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The successful treatment, control and prevention of lameness in dairy cattle needs a combination of relevant data, current information, broad knowledge, open and analytical minds, patience, teamwork, resources, motivation, and labour.

These guidelines and factsheets aim to:

- provide a base of current information in a reader-friendly format,
- increase knowledge about lameness treatment and control in the dairy farming population,
- improve treatment techniques,
- provide a comprehensive list of strategies to better control lameness,
- improve the welfare of dairy cattle,
- promote cooperation between dairy farmers and their advisors,
- reduce human stress and financial losses associated with lameness,
- and so improve the viability of the Australian Dairy Industry.

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Our sincere thanks

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How best to use this guidebook

If you are inexperienced in treating lame cows.., read guidelines 1 to 8 before treating lame cows.

If you have some experience in treating lame cows, but wish to improve your technical expertise.., read the appropriate guidelines, and include guidelines 2 and 7.

If you are treating a lame cow, and are unable to identify the cause.., read guideline 7.

If you are treating a lame cow, and the case does not respond to treatment.., read guideline 7.

If you are treating a lame cow, and have identified the cause of lameness, but are unsure of the best treatment.., read the appropriate Factsheet.

If you suspect too many cases of lameness are occurring on your farm.., read guideline 7.

If your farm is experiencing an outbreak of lameness.., read "Lameness is a multifactorial problem" and work through "Guidelines 9 to 16" with a veterinarian or animal health consultant. Prioritise the required changes to management, then systematically implement them until the outbreak is controlled.

If you are unsure of what lameness is costing you, or wish to justify additional expenditure on the control of lameness.., read "What does lameness cost a dairy farmer?"

If you do not understand why lameness occurs on your farm, or in an individual animal, read "Lameness is a multifactorial problem" and "Guidelines 9 to 16".

To reduce occupational health and safety risks associated with treating lame cows.., Read Guideline 2.

If you discover blisters between the claws, on the coronet, or on the tongue of any animal at any time, immediately call a veterinary surgeon or government stock inspector. The presence of blisters may indicate Foot and Mouth Disease. Should Foot and Mouth Disease enter Australia, its control and eradication will depend on immediate recognition and reporting!

What does lameness cost a dairy farmer?

What does lameness in cattle cost the individual dairy farmer, and the Australian Dairy Industry as a whole?

Lame cows are less willing to walk, and prefer to lie down. Time spent grazing or competing for food is reduced. Food intake declines, and with it, milk production and body weight.

Reduced food intake results in a negative energy balance may interfere with breeding performance by reducing conception rates, by delaying the onset of first heat after calving, and by reducing the visible signs of heat. Poorer fertility increases the risk of cows being culled because they are empty.

Culling for infertility incurs costs in terms of the herd's subsequent production, and lowers genetic gain.

Animals culled because of the lameness itself have a much reduced market value because of the loss of bodyweight.

The key factors that contribute to the cost of a single case are:

- Loss of milk production
- Lowered fertility
- Increased risk of culling
- Treatment costs

In order to determine costs, each factor is costed individually:

Loss of milk production

A number of studies have shown that one or more episodes of lameness significantly lowers milk production in affected cows. In one study, lame cows on average lost over 300 litres of milk, 13 kgs of milk fat and 13 kgs of milk protein over their entire lactation when compared to sound herdmates.

Another study, the InCalf project, demonstrated that lame cows produced about 160 litres of milk, 3.5 kgs of milk fat and 6.7 kgs of milk protein less over a lactation than non-lame cows.

If the average price of milk paid by milk factories is 25 cents per litre, this loss ranges from $40 for the lower finding to $75 for the higher finding.

The extent of the loss in individual cases will vary according to the severity of the lameness, its duration, and the stage of lactation. Some mild cases that respond to treatment in one day may not show a significant difference in production compared to unaffected herdmates, whereas cows severely lame over a long period of time may lose significant quantities of milk production.

Lowered fertility

The InCalf project demonstrated that cows becoming lame during the post-calving or mating periods had not-in-calf rates 11% higher than unaffected herd mates.

Typically, herds with higher not-in-calf rates have fewer voluntary culls (cows culled for low milk production). Every extra non-pregnant cow will result in one less voluntary cull. If a herd manager is forced to retain a low-producing pregnant cow because of one extra non-pregnant cow, herd milk production in subsequent years will be reduced, all other factors being equal. The difference in production in subsequent years is estimated to be about 1,100 litres for every extra non-pregnant cow, and the consequent retention of a low-producing cow.

In addition, the "lost daughters" of involuntary culls would be genetically superior, and so would have a higher production potential compared to daughters retained from low producers.

Conservative estimates place the cost of an involuntary cull caused by an event such as being empty at the end of lactation at $1500. An 11% greater risk of incurring this loss is costed at $165.

Another way to value the cost of a not-in-calf cow is to estimate the difference between her market value when culled, and the cost of buying her replacement. At the time of writing, this difference is estimated to be approximately $800. An 11% greater risk of incurring this loss is costed at $88.

Increased risk of culling

Further analysis of the InCalf data showed that even if lame cows became pregnant, an episode of lameness caused an additional 2½% risk of culling. This is likely to be due to low milk yield and/or poor body condition due to the lameness episode.

This cost can again be expressed in terms of the difference in returns between involuntary culls, such as those animals culled because of lameness, and voluntary culls culled for low production. A 2½% greater risk of incurring this loss is costed at $37.

Treatment costs

The cost of treatment will vary depending on:

- the type of disease causing the lameness, and its severity
- the amount of time spent on the case by the farmer
- if antibiotics are required as part of the treatment
- if milk has to be discarded because of antibiotic use
- if veterinary examination and treatment is required

It is estimated that a mild case of lameness costs approximately $20 to $25, a severe case $90, and on average, the financial penalty is approximately $35.

The hidden costs of lower production and fertility, and an increased risk of culling far outweigh more visible costs such as treatment and discarded milk.

Add up the costs

Lowered milk production = $ 40 - $75

Lowered fertility 11% of $800 -$1500 = $ 88 - $165

Increased risk of culling 2.5% of $1500 = $ 37

Treatment costs = $ 35

Total = $200 - $312

Thus a single case of lameness costs approximately $200 to $300.

Individual farmers can calculate their average annual cost of lameness by multiplying the estimated cost of a single cost of lameness (calculated above at $200 to $300) by the number of cases of lameness in their herd each year.

Using this data and other estimates, lameness is thought to cost the Australian dairy industry over $30 to $45 million dollars per annum.

Lameness in cattle also has a "human cost". A simple, single case of lameness is frustrating to the farmer because it takes time to treat time that could be better used elsewhere "on the farm or off it".

In outbreaks of lameness, the financial costs and demands on time mount up. If the farm is experiencing financial hardship, or if resources of time or patience are limited, such outbreaks can become emotionally painful. Humans also find the sight of animals in pain distressing. Seeing large numbers of animals in severe pain such as in an outbreak of severe lameness is very distressing.

Lameness is a "multifactorial" problem

When a lame cow is examined, occasionally a single factor can be easily identified as the cause of the problem. For example, if a nail is found driven through the sole of a hoof, the cause is obvious, and the treatment straightforward remove the nail, and counter infection.

However, cases of lameness in which a single cause is easily identified are unfortunately rare.

Even in a seemingly straightforward case of footrot, multiple factors may be involved. For example, an excessively wet environment may soften skin and make the foot prone to puncture between the claws. If small, sharp stones are present in the environment, they may lodge between the claws and cause a break in the skin. High numbers of bacteria in the environment during an outbreak may lead to overwhelming contamination of a puncture site, and subsequent infection. Each factor is not the sole cause, but when acting in combination, a simple case of footrot results.

In many other foot disorders, for example, abscess of the sole or white line disease, a large number of factors that increase the risk of an abscess developing may be present.

When a number of factors increase the risk of a disease, the disease is said to be multifactorial.

It is important to recognise the multifactorial nature of lameness in dairy cattle, because:

- focusing resources on one factor may result in little progress, even though that factor is a critical point in control of the disorder. Indeed, a disease situation may deteriorate even though an appropriate action is taken. A belief may develop: that this strategy was a waste of time or money.
- focusing resources on one factor may result in apparent progress, even though that factor is not critical to the development of the disorder. A belief may develop: this factor is "the cure". For example, a trace mineral is added to the diet as other conditions improve, and the trace mineral is subsequently regarded as the key to success.
- a large number of separate factors may need to be addressed for progress to occur, and this task may be beyond current resources of time or money. For example, farm hands may need training, and extensive sections of a track may need repair during a busy time of the year when cash flow is poor.
- progress towards control may be slow. For example, if foot shape is poor due to nutritional imbalances or inherited conformation faults, immediate improvement will not occur.
- some factors may be beyond the ability of management to control. For example, track repair may be impossible in prolonged wet weather.

In order to control lameness, it is important to recognise its multifactorial nature.

Many factors increase the risk of dairy cattle developing lameness:

- adverse changes to cow behaviour,
- poor quality walking surfaces,
- restrictions to ideal cow flow,
- human actions that cause adverse changes to cow behaviour,
- excessive wetness in the environment,
- the build up of bacteria,
- imbalances in nutrition,
- and genetic faults leading to poor conformation.

It is within the power of management to reduce or eliminate many of these risks. These factors are discussed in Guidelines 9 to 16.

Lameness is an animal welfare issue

Lameness is recognised as one of the major animal welfare issues in pasture-based dairy production systems.

Lameness is the disruption to normal gait caused by pain due to injury or disease.

Pain can be defined as "an unpleasant sensation or emotional experience, associated with actual or potential tissue damage". While pain has a protective role (it warns the animal of potential or actual tissue damage, and normally causes a change in behaviour to prevent further damage), chronic or prolonged pain associated with lameness is clearly a welfare issue for the animal.

Freedom from pain, injury and disease is one of the so-called "Five Freedoms". People involved in the care of dairy cattle have a moral obligation to provide this freedom and so protect the welfare of their animals.

The animal is entirely dependent on humans for its care and survival. It is not able to identify the cause of lameness, treat itself, provide pain relief, or adjust its environment so that injury does not recur! Only the owner, the owner's representatives, and animal health professionals can do so.

The Australian dairy industry is based on, and entirely depends on dairy cattle. Prompt and effective treatment of lameness, and taking action to prevent lameness promotes both the production and welfare of dairy cattle. It is the least we can do for them!

Individual cow guidelines

1. Understand normal foot anatomy to treat and control lameness more effectively

- hooves are made of protein that softens with moisture
- on the outside: the wall, the sole and the heels
- on the inside: the corium and the pedal bone
- hoof design makes it prone to injury in adverse environments

Understanding a normal cow's foot is very important:

- for effective treatment of hoof disorders. (If you had a sore foot, you wouldn't go to a doctor or podiatrist if they didn't know how a normal foot functioned.)
- for consideration of strategies to control and prevent lameness.

1.1 Understand that the claws are made of a hard protein that softens in moisture

The two claws of a cow's foot are made of hard protein called keratin. It gives the claws their toughness, and protects the cow's foot from daily wear and tear.

The protein of keratin can absorb water. This is important because if hooves are continually wet, the keratin becomes softer, and more easily damaged. For this reason, wetness and moisture can contribute to lameness. Dairy cows living in high rainfall areas, or under intensive conditions such as calving pads and feedlots, can have continually wet and soft hooves.

On the other hand, if hooves are continually dry, the keratin becomes very hard, brittle and can crack more easily.

1.2 Recognise the three main parts of the hoof

- The hoof seen from the front or the side view is called the wall.
- The hoof that you see from the rear is divided into two bulbs or heels, one for each claw. The bulbs or heels are covered in thin skin above the ground, and much thicker hoof material where they contact the ground.
- Lastly, under the foot is the sole. A cow bears most of her weight on the wall where it contacts the ground, and the heel, and usually bears very little weight on her soles. Check the hoof print of a cow made by wet hooves on a dry surface to confirm this fact.
  The sole is about 5 mm or ¼ of an inch thick, and is normally concave when viewed from below. Despite the fact that it bears little weight, it can still be worn away. For example, if the ground is particularly abrasive, or if the sole is turned or twisted on the ground too frequently, or if cows are walking long distances, the wall of the hoof wears away, and the sole of the hoof starts to bear more of the weight of the cow. The hoof material or keratin is scraped off to the point where the sole is thinned or worn out. Thin soles are more liable to injury or puncture through to the underlying soft tissue.
  Soles can also be too thick (especially in older cows with elongated claws). Then the cow bears too much weight on the sole instead of the heel and wall, and this can cause bruising and pressure ulcers.
- The junction between the normal skin above, and the wall and heels beneath is called the coronet. The wall grows down from the coronet at ½ to ¾ cm per month, or 8 cm per year.
- The junction between the wall of the hoof and the sole is joined by a specialised cementing material, and is called the white line. This is a potential area of weakness of the hoof, and is the area affected by white line disease.

1.3 Gain an understanding of the internal structure of a cow's foot.

- Just beneath the hoof is the area responsible for continually growing new keratin â€“ the corium. Fresh keratin is constantly needed to replace hoof material which wears out with daily use. The corium is very rich in blood vessels that supply nutrients required for hoof growth. (Inflammation of this area is called laminitis.)
- It is also rich in nerves that sense the ground surface as a cow walks, and sense pain when the hoof is damaged or diseased.
- Enclosed in a protective layer of hoof, and nourished by blood vessels of the corium is the pedal bone. Strands of strong fibres join the hoof and sensitive hoof-growth area directly to the pedal bone. There is also a cushion of elastic fibres and fat between the pedal bone and the heels. It protects the sensitive corium from downward pressure of the pedal bone and upward pressure of uneven surfaces on the sole as the cow walks, absorbing concussion.
- The pedal bone connects with other small bones in the foot. Joints between these bones give the foot flexibility. Tendons link the bones to muscles up the leg, allowing the foot to move forwards and backwards in normal movement.
- Understanding this structure is important for managers wishing to better control lameness. As an example, imagine a cow walking on a sharp stone. The pedal bone presses down with say 140 kilograms (or more) of body weight above it. The sole bends upwards because of the stone under it. This upward flexing is more pronounced if the sole is soft due to excess moisture. The corium is squeezed between a rock and a hard place and damaged. A bruise develops in the corium, and because of the nerves in the area, pain, lameness and consequent losses result. Knowledge of this sequence leading to lameness clarifies the importance of such issues as selection of track surfaces, track maintenance and cow handling.

2. Examine and treat lame cows safely

- occupational health and safety issues
- risks to operator
- make a safe area for examination
- risks to cows too

Examining and treating the lame feet of cattle is a potentially dangerous procedure for the operator. The process poses a variety of risks. People who examine and treat lame cows should be aware of these risks, and take action to minimise potential injury and illness. Obviously cows are powerful and quick moving animals when threatened or in pain, and kicks can cause severe injury. Kicks can also knock tools used to examine hooves, and the tools in turn can injure the operator.

The procedure is also risky for cows, and significant injury can occur as a result of their kicking, struggling or slipping, complicating the initial problem. Steps should be taken to minimise risks to cows.

2.1 Make examining and treating cows a safe procedure for the operator

- To prevent illness from Leptospirosis, avoid urine splash. Vaccinate cows annually.
- Make sure you have a good crush in excellent working order. All moving parts should be well lubricated. Split side gates with open rails are preferable to allow access to front feet.
- When attaching a rope to a hind foot, never place your head below the level of the stifle of the cow. Never place your arm or wrist through the side of a crush. To save back strain, use a pulley system to lift the foot, running from the leg to a high rail, back to the leg, then back to a rail. Secure the foot tightly both in the horizontal and vertical directions. Never place your face near a hindfoot to take a close look at it.
- Cows can kick well forward with their hind feet (they can scratch their ear with their hind foot), so when examining a front foot, to avoid facial and head injuries, always rope the hindfoot (on the same side of the animal) first. The foot should be allowed to rest on the ground, but its movement forward should be restricted.
- If using a hoof knife, to avoid severe cuts, always keep the hand holding the hoof behind the hand holding the knife.
- Clean the foot well before starting work with a hoof knife. If hands and knife handles are dirty, they can become slippery. Under these conditions, you are more likely to slip while paring and cut yourself.
- If using a disc grinder, to avoid electrocution, keep electrical joins elevated and away from any water or urine! Tie the end of the extension lead to the top of the crush. Always use a circuit breaker. Use ear and eye protectors. Do not use electrical tools in the rain. Have a helper hold the electrical lead so it cannot be caught in the disc.

2.2 Make examining and treating cows a safe procedure for the cow

- When lifting a hind foot with a rope, use a slip knot to tie off the rope. If the cow slips or goes down in the crush, and the foot remains tied up, she can dislocate her hip. You have to be able to release her foot quickly.
- Check there is no restricting rail around the throat region of the cow. If she slips, she can choke.
- Cows can injure themselves by kicking back and forth repeatedly. Check that no bracket, rough edge or flange can rub against a roped-up leg. If necessary, tie a hessian bag or sack around the upright of a crush to protect the cow's skin and tendons. Secure the foot tightly both in the horizontal and vertical direction.
- If using hoof knives or nippers, keep the cutting edges sharp so that a minimum of force is required to cut the hoof material.
- If using an angle grinder with a coarse paper disc, replace the disc regularly. Discs that are worn out burn the hoof.

3. Examine and treat lame cows promptly

- minimise severity of disease and pain
- decrease associated losses
- reduce spread of bacteria
- alert staff

Many conditions that cause lameness progress from minor conditions to severe disease with time. Prompt identification of the problem, and effective treatment can arrest this progression and minimise damage to the affected area of the foot or leg.

For example, footrot often starts as a mild infection of the foot due to a wound in the skin between the claws, or due to a foreign body (such as a stone) lodged between the claws. Prompt examination will reveal the wound or foreign body, and subsequent treatment with a course of antibiotics often results in a rapid return to soundness. Delayed treatment can cause massive swelling of the whole foot and leg and prolonged healing. In very severe cases, infection can extend into the joints of the foot, or tendon sheaths of the leg, resulting in loss of the animal.

As a second example, an abscess in the sole of the foot starts as a small pocket of pus in the claw, and prompt detection and drainage will prevent the pus spreading to affect the whole claw. Delayed drainage will result in expansion of the pocket, and the whole sole can be underrun and lifted from the sensitive layer. This causes increased pain, prolonged healing, and a much delayed return to soundness.

Increased severity of lameness due to delayed treatment results in a greater loss of milk production, body condition and reproductive performance, and greater labour costs and financial losses.

In addition, an animal severely infected with footrot is discharging billions of bacteria into the environment, increasing the risk of infecting other cows, potentially contributing to an outbreak and further losses.

3.1 Examine lame cows within 12 hours of detection.

Cows first detected lame on their way to the morning milking should be drafted out of the herd, examined and effectively treated that day. Cows first detected lame on their way to the evening milking should be drafted, examined and effectively treated no later than the following day.

3.2 Inform staff including relief milkers of the need to examine and treat lame cows promptly.

Farm hands and relief milkers may not be aware of the importance of prompt examination and treatment. In the event of your absence, make sure all those who milk or handle cows are informed of this requirement. If they are not confident to examine or treat lame cows, they should be advised to seek professional help immediately.

4. Purchase, maintain and use the correct equipment

- keep a basic kit for checking claws
- hoof testers are essential
- special equipment is needed to treat difficult disorders
- only experienced operators should use power tools

The treatment of some disorders, such as a stone between the claws, is simple and little equipment is needed.

However some conditions, such as axial groove cracks, sand cracks and some sole abscesses require experience and special tools.

Gain experience by watching professional operators, asking questions and only treating conditions when confident to do so.

4.1 A suitable crush in good working order is highly recommended for the safety of the operator and animal. Alternatively use a walk-through bail.

- The method of restraint should be designed so that a hind limb can be securely fastened for safe and efficient examination and treatment of the hoof. The sides of the crush should be rails, not solid walls, so that a front foot can be roped to the outside of the crush for a safe and thorough examination and treatment.

4.2 Always have a set of basic hardware well-maintained and ready to use.

- Leg ropes or straps. Two ropes or straps are required when examining front feet; one to lift the front foot, one to prevent the hindfoot striking forward. Soft rope is preferred to prevent rope burn.
- Hoof knives, one right-handed, one left-handed. Narrow blades are easier to use than wide blades, especially between the claws. Single bladed knives are safer than double bladed knives as they are less likely to cut the operator's hand if driven backwards by a kick. Keep the blades sharp by using a fine, round chain saw file for the inside edge of the curled section, and a stone or Dremel power tool for the rest of the inside edge. Do not sharpen the flat, outside edge.
- A glove for the hand holding the foot.
- Hoof trimmers or nippers, single- or double action.
- Hoof testers. These are essential and are used to locate the painful area. Occasionally, fine hoof cracks are very difficult to see, but are located by using hoof testers to place pressure on the claw. Under pressure, a small bead of pus, muddy water or air can escape from the crack, aiding detection. Applying equal pressure to both claws will allow the operator to decide which claw is painful, and where to concentrate their examination.
- Dressings: Antiseptic spray, bandages, glue-on plastic shoes and shoofs.
- A hose or bucket of water and a brush are essential for cleaning the hoof, coronet and pastern thoroughly.

4.3 Power tools are a valuable aid for experience operators

- Checking, paring and trimming claws can be hard physical work. The use of a power tool makes the job less physically demanding, and in experienced hands, can add precision to a job.

However, power tools must be used with considerable care. They have the potential to seriously injure operators: in the event of sudden cow movement, the spinning disc can be forced against the operator. Protective eye goggles or glasses must always be used when using such tools. Angle grinders should only be used on the feet of animals that are very well restrained.

Operators should also be aware that an excessive amount of heat can be generated in the hoof when using an angle grinder, and if this occurs, hoof damage can result.

If not used carefully, angle grinders can rapidly remove too much hoof horn, exposing the underlying sensitive layer of hoof, and increasing the degree of lameness of the affected animal.

- A 4" disc grinder can be use to clean soles, reveal disorders, explore cracks, shape vertical walls and remove overgrown areas.
- A Dremel drill can be used to explore and pare out axial wall cracks and sand cracks.
- Always keep the power source above and away from water.
- Always have a circuit breaker between the power tool and the power source.
- Always have an assistant hold the electrical lead so that the tool does not cut through the lead.

5. How to lift a cow's foot

- Always consider safety of the operator
- Always consider safety of the cow

Facilities for restraining cows and lifting the front or back feet vary widely in type from farm to farm, and it is beyond the scope of these guidelines to provide hard and fast rules. Crushes and races vary in their ability to provide safe access and thorough examination of cattle feet, and often accessibility to the front feet is poor.

5.1 How to lift a front foot.

- Cows can kick well forward with their hindfeet, so when examining a front foot, to avoid facial and head injuries, always rope the hindfoot (on the same side of the animal) first. The foot should be allowed to rest on the ground, but its movement forward should be restricted.
- If the cow is excitable, upset or frightened have an assistant apply a tail-jack, or consider sedation of the cow.
- Fasten a rope to the lame foreleg just above the fetlock, and well below the knee. Use a slipknot or a rope with a loop spliced at one end.
- Pass the rope over a rail at about the level of the cow’s elbow, from the inside to the outside of the crush or bale.
- Loop the rope back around the leg at the same level as the original tie.
- Pass the rope over a lower rail at about the level of the cow’s knee, from the inside to the outside of the crush or bale.
- Lift the foot, using the two passes of rope as a pulley.
- To make examination possible, bring the foot to the outside of the crush or bale, either above or below a lower rail, and lash it securely to the rail so movement is prevented.

An alternative approach, when cattle are restrained in a head crush is as follows:

- An assistant leans against the back end of the cow so her ability to kick forward is restricted.
- A rope (with a slip knot at its end, so it can form a loop around the leg) is fastened around the foreleg to be examined. The loop is placed midway between the knee and the fetlock.
- The end of the rope is taken over the cow, and around a rail on the other side of the crush.
- The rope is then passed back under the cows armpit, and again back over the same rail. This loop acts as a sling to support the cow.
- The assistant (who is still leaning against the back end of the cow) pulls on the end of this rope while the operator lifts the front foot.
- The front foot then can be examined.

It is often more difficult to lift a front foot than a hind foot. In some cases it is safer, and makes for easier examination, to cast the cow and restrain her, so that the foot can be examined and treated. Sedation may assist casting.

5.2 How to lift a back foot.

Use a slipknot or a rope with a loop spliced at one end. The rope can be fastened to the lame hindleg at one of two sites - either just above the hock, causing pressure on the achilles tendon and so restricting movement, or just above the fetlock so that the foot can be securely lashed to a rail or upright, restricting movement.

- Irrespective of the method of lifting, it is important that subsequent movement is well restricted; otherwise kicking during examination can cause the operator's tools to be knocked, and driven into the operator's hands or other parts of the body, causing injury.

- The rope is then passed over a high rail, back around the leg above the hock, and then back to the same or a lower rail. Pulling on the rope will cause a pulley action. Once the foot is lifted, it is roped to a rail or upright securely so that movement up and down, or forward and backward is very limited.
- It is preferable that the rope is then held by an assistant rather than tying it up. If the cow slips in the bail or crush, or goes down, it is important that the rope is released quickly to prevent dislocation of the hip.

6. How to examine a cow's foot

- systematic approach
- thorough search
- use hoof testers

Most causes of lameness in cattle are caused by disorders of the foot, so after the animal has been examined standing and walking, if there is no obvious abnormality, examination of the foot is the next step.

It is important that the examination is systematic, so that no area is left unchecked, and that it is thorough â€“ some causes of lameness, particularly hoof abscesses, show little or no visible signs on the sole surface.

6.1 Look at the cow standing and walking.

Prior to foot examination, look closely at the cow as she stands and walks.

Look for obvious signs of swelling or muscle wastage. Footrot often causes swelling above both claws. Foot abscesses can cause swelling of the bulb of one heel. Hip arthritis can cause wasting of the muscles of the rump, whereas a dislocated hip in a standing animal can cause the same muscles to appear swollen.

Check for wounds in the skin and discharge. Foot abscesses can cause a break in the skin at the heel or coronet. Puncture to the skin anywhere on a leg can cause infection, discharge, swelling and lameness.

Look at the way the cow stands. Both hindfeet held under the cow (camping forward) could indicate toe pain, or laminitis. Both hindfeet held well behind their normal position (camped behind) can indicate heel pain. If either the front or back legs are crossed, pain may be present in both medial (inside) claws. If the cow stands with her lame leg extended away from her body, this may indicate that the outside claw is painful, and should be checked first. Similarly, if the inside claw is affected, the cow may stand with her leg pulled in under her body, so that she bears her weight on the outside claw. If one leg is held off the ground, pain is severe, and a toe abscess, severe infection or even a fracture may be present.

Examine the way the cow walks. Determine which leg is lame. (Tip: The lame leg is usually opposite the leg that is moving forward fastest at the walk.) Short, rapid steps, especially if the back is hunched, may indicate pain in more than one foot.

6.2 If the cause of lameness is not obvious, lift the lame leg and clean the foot thoroughly.

Cows often walk in dirt, mud or manure, and the cause of lameness is easily missed in the contamination. It is essential that the two claws and the space between them are cleaned thoroughly, preferably with water and a scrubbing brush. In particular, the soles must be scrubbed clean.

6.3 Check the space between the claws, and explore the tight area between the heels with a finger.

The area between the claws is a common place for foreign objects to lodge, especially stones or sticks. These can cause pain and lameness in their own right, or cause a break in the skin, allowing the footrot bacteria to enter the tissue of the foot and cause infection. Remove any foreign objects.

Footrot also may be present without a foreign object between the claws. The split in the skin, and swelling of the foot in a case of footrot may occur at the front of the interdigital space, in the middle, or at the back of the foot, between the bulbs of the heels. Although it is difficult to examine this area as space is limited, it is still important to do so. Otherwise foreign objects or cases of footrot will be missed

The area should also be checked for growths (interdigital fibromas), dermatitis (hairy warts) and blisters or vesicles (foot and mouth disease).

6.4 Scrape or sand the entire surface of both soles to check for cracks, bruises, white line disease or ulcers.

A hoof knife can be used to scrape the soles, or a 4" angle grinder with a coarse paper disc used to lightly sand the soles clean. Any crack in the walls or along the white line, or any cut on the soles must be followed until it vanishes, making sure that it is not the cause of an abscess. The entire sole should

be checked for bruises. The area towards the heel should be checked for ulcers, and the point of the toe examined for excessive wear, especially in heifers.

Areas of exploration along the wall should be cleaned out so that a cavity packed with gravel does not develop.

See Factsheets for a description and treatment of bruises, white line disease, underrun soles and ulcers.

6.5 If no abnormality is found, it is important to check the sole of both claws with hoof testers.

Occasionally, cracks causing hoof abscesses are very fine, and difficult to detect with the naked eye. Placing pressure on the soles of each claw with hoof testers may not only detect pain, but also cause a small amount of pus or water to ooze from the crack under pressure, making detection easier. If the sole is wetted, a small bubble of air may escape from the crack when pressure is applied with the hoof testers, again assisting detection.

6.6 If no abnormality is found on the soles, it is important to examine the rest of the foot.

Check the axial hoof wall (between the two claws) for axial wall cracks. Examine the vertical hoof wall for cracks â€“ especially at the front of the claws, and look closely at the coronet for evidence of abscesses that have ruptured to the exterior in this area. Check the bulbs of the heels, especially where the skin meets the hoof, for evidence of abscesses that have broken out at this point.

6.7 If no abnormality is found in the foot, it is important to examine the rest of the leg closely.

Check the leg for wounds, and the fetlock, hock and stifle joints for swellings.

6.8 If you are unable to find the cause of the lameness, or provide effective treatment, call your veterinarian for expert assistance.

7. When to seek expert opinion or assistance

- know when to seek the advice of experts
- use veterinary surgeons or animal health consultants when necessary

There may be occasions when effective treatment of an individual case of lameness or control of an outbreak of lameness in a herd is beyond the ability of a farmer or herdsperson. Veterinary surgeons and animal health consultants represent a vital source of information and assistance, so that effective treatment or control is provided.

7.1 Call a veterinary surgeon or animal health consultant when:

- a lame cow is examined and the cause of the lameness cannot be determined.
- technical skills, drugs or equipment are lacking to effectively treat a lame cow.
- a lame cow is treated, and the lameness does not show marked improvement in three days.
- the lameness is so severe that the animal is in severe pain.
- there is an outbreak of lameness in a herd, and the cause is not obvious or it is not known how to rectify the cause.

If a farmer is in doubt about whether their herd is in an outbreak situation, they should contact their local veterinarian who will have knowledge of the normal prevalence of lameness in the district for that time of year. An estimate of the cost of an outbreak can be calculated using the values in "What does lameness cost a dairy farmer?" in the Introduction.

An outbreak of lameness in a dairy herd can be expensive in terms of lost production, but it also impacts severely on the farm operators workload, and on the welfare of the affected animals. The role of a veterinarian is critical in an outbreak because they may identify the likely cause(s) from examining the hooves and feet of lame cows. Once a cause is identified, effective control measures can be employed.

If you discover blisters between the claws, on the coronet, or on the tongue of any animal at any time, immediately call a veterinary surgeon or government stock inspector. The presence of blisters may indicate Foot and Mouth Disease. Should Foot and Mouth Disease enter Australia, its control and eradication will depend on immediate recognition and reporting!

8. Know when to use antibiotics

- only use antibiotics when the cause of the lameness is known
- know which conditions require antibiotics
- use antibiotics only when necessary
- obey milk withhold periods

As a general rule, the use of antibiotics should be minimised. Overuse increases the risk of bacteria becoming resistant to antibiotics, so that subsequent treatments are ineffective. Overuse also increases costs unnecessarily, and in some cases, wastes milk and increases the risk of bulk milk contamination.

8.1 Identify the cause of lameness prior to the use of antibiotics

- Only some conditions respond to antibiotics (see below). Do not use antibiotics if you have failed to identify the cause of the lameness.

8.2 Use antibiotics

- in most cases of footrot.
- in cases of white line disease, underrun soles, sand cracks, axial wall cracks, and interdigital fibroma only if the tissue surrounding the affected area is swollen, or if the foot is swollen.
- In cases of hairy heelwarts, antibiotics are better applied to the surface of the infected area rather than injected.
- Antibiotics are usually not required in cases of bruised soles when the sole is not perforated, and in cases of subclinical or chronic laminitis.

8.3 If in doubt, seek the advice of your veterinarian

8.4 When you use antibiotics, obey milk and meat withhold periods

Herd guidelines

9. Take action when you see adverse changes to cow behaviour

- cows have a "safe" walking action to minimise the risk of injury.
- the "safe" walking action should be preserved in a herd situation.
- other cows or human actions may change the "safe" walking action.
- look for changes in the cows walking action

Some aspects of cow behaviour the way they walk, their interaction with other cows, and the way they respond to human actions strongly influence the risk of lameness.

Left to her own devices, a cow will attempt to walk in a safe manner, carefully placing her feet to minimise the risk of hoof injury. However in reacting to other cows and to human actions, she may unintentionally place her feet in a manner than risks hoof injury, lameness, and the losses associated with it.

The safe way cows walk:

- When an individual cow walks at her own pace, on the track or in the yard, she looks carefully at the ground, and selects and places each front foot in the safest spot, avoiding stones and uneven ground. Her hind foot follows, landing in the same safe spot that she selected for her front foot. In this way, she naturally avoids hoof injury.
- If a cow accidentally stands on something that may injure her for example, a sharp stone she uses the weight of her head to counter balance her bodyweight, reducing pressure on the claw at risk. She raises her head if pain or risk of injury is detected (by nerves) in the front foot, and lowers her head for a hind foot at risk.

The safe way a herd walks:

- In a herd situation, when cows are collected from a paddock for milking, the cows sort themselves out into a pecking order, enter the track, and string out due its narrowness. The cows then follow one another in lines, and a relatively smooth "cow walk" is established.
  As they walk at an undisturbed pace (drift) along a track, they still keep their heads down to select a safe place for front foot placement. If they are walking in a relaxed fashion, hindfeet follow, placed in the same safe spots. Drifting cows tend to follow one another in lines, even placing their feet in the same place as the cow they are following.
- The herd's normal "pecking order" affects cow flow. The order in which cows drift down a track is not random. The most dominant cows form a middle group. Second order dominance cows are out front, and the least dominant cows bring up the rear.
  Drifting cows avoid touching other cows even if moderately bunched. If a dominant cow decides to stop, the cows behind bunch up and stop to avoid contact. The cows in front also slow down and even stop, apparently waiting. The whole flow comes to a halt for 10 to 15 seconds, and then the most dominant cow moves again. As they have almost 360 o vision, the front cows immediately move forward as if pushed. The rear cows seem to be pulled forward by the movement of the dominant cow. This push-pull effect is happening all the time at different points in the herd as they flow in a stop-start manner towards the milking shed.
- Once a herd has learned the normal routine of a milking shed, they will flow into the yard, settle into a standing position, and wait to move into the milking bail.
  Ideally, they will stand with their heads down and move forward slowly as the milked cows move out of the bails. While they wait, cows of higher dominance will occasionally butt other cows, and slight readjustments in position will constantly happen. Every now and then, a cow will move, usually from a middle position towards the bails, pushing gently between cows if the herd is not too tightly packed.
  At both an individual cow and herd level, normal behaviour is "safe".
  When other cows or human actions disturb this safe behaviour, an individual cow reacts in a number of ways that increase the risk of foot injury.

- Her stride shortens, so the hind feet are not placed on the same safe spots as the front feet. Because she cannot see where the hind feet are being placed, there is an increased risk of unsafe placement.
- In a herd situation, she lifts her head over the back of other cows in front of her, and she cannot see where to place her front feet wisely. Once again, because the hind feet follow the front feet, the landing place for the hindfeet is unplanned.
- When heads are raised in a tightly packed yard or in a bunched herd on a track, the weight of the head can no longer be used to counter balance a cow's bodyweight when a claw is placed on a stone, increasing the risk of bruising and sole puncture.
- Because cows dislike body contact with other cows, tussling and even fighting results, resulting in unsafe fore- and hindfoot placement.
- Cows no longer drift in lines following each other's foot placement, but change from one side of the track to the other, further risking foot injury.
- If a cow is on the edge of a track and at risk of being forced against a fence by the herd, she will usually stop and lean on the cows that are pushing her. She pushes with the back leg closest to the cow she is leaning against, (opposite to what a human would do) and most of the force is taken by the outer (abaxial) wall of the outer claw of the foot, adversely stressing the white line. (The white line is a weak point in the "design" of the claw.)
- Pushing increases the risk of skidding and injury on slippery surfaces.

9.1 Take action when you see adverse changes to cow behaviour

- Look for the "safe" walking action of individual cows: their head remains lowered; they look for a safe spots to place their forefeet, and their hind feet follow, placed in the same safe spots.
- Look for the "safe" walking action of a herd drifting along a track. Cows tend to follow one another in lines, even placing their feet in the same places as the cow they are following. They flow in a stop-start manner towards the milking shed.
- Look for the "safe" routine of a herd at the milking shed: cows flow into the yard, settle into a standing position, and wait to move into the milking bale.
  They should stand with their heads down and move forward slowly as the milked cows move out of the bails. Cows of higher dominance will occasionally butt other cows. Slight readjustments in position will constantly happen. Every now and then, a cow will change position, usually forward.
- Watch for adverse walking actions that increases the risk of foot injury: a quicker, shortened stride.
- While the herd is walking along the track, entering the yard, or waiting to be milked, watch for adverse behaviour that increases the risk of foot injury. Adverse behaviour includes: lifting of heads over the backs of other cows; no longer drifting in lines, but changing from one side of the track to the other; leaning on other cows; bracing if being leaned upon; tussling, fighting and slipping.
- If you see adverse walking actions and behaviour, follow Guidelines 10, 11, 12 and 13 immediately.

10. Construct and maintain high quality walking surfaces

Please refer to Factsheet M: Notes on construction of a farm track

11. Construct and maintain tracks and yards to permit ideal cow flow

- restrictions to ideal cow flow slows the herd down
- slow progress may cause the herdsperson to be impatient
- impatient human behaviour increases the risk of lameness

Many factors can restrict or impede ideal cow flow. Some examples of restrictions are broken sections of track, a sharp right angle bend in the track, a narrow crossing over an irrigation channel, or a narrow entrance to the yard.

When flow is restricted, at least three scenarios can develop:

- Some cows stop completely, chew their cud, and think about the obstacle.
- The cows form rows to get past the obstacle. For example, the herd may flow five cows side-by-side along a four metre wide track, but to get around a right angle bend, they usually reduce to three cows wide, causing cows at the back of the herd to slow down.
- Some obstacles cause the cows to change their stride length and walking more slowly.

If the herd is allowed to drift past the obstacle, adverse changes to walking behaviour are minimised. Cows keep their heads down, select a safe spot for their front feet, and back feet follow front feet onto the same safe spots. Cows maintain their correct place in the pecking order, and so there is little body contact, pushing or tussling.

Because the herd slows, herd persons may try to speed the herd past the obstacles. When this occurs, adverse changes to the way cows walk and behave result, and the risk of injury and lameness increases. (See Guidelines 9 and 12 for further information on adverse changes to walking action and behaviour.)

11.1 If constructing tracks, make sure they are sufficiently wide.

- Use the following table as a guideline for track width:

Size of herd	Width of track
< 120 cows	5 metres
120-250 cows	5.5 metres
250-350 cows	6 metres
350-450 cows	6.5 metres
> 450 cows	As required

- The track should be an even width along its length.
- The track should widen by an extra metre prior to the yard entrance.

11.2 Observe cow flow on the track

- On wide, dry and safe cow tracks, a herd should move at 4.5 km/hour. On a wet, narrow or rough track movement can slow to 1.5 km/hour.

11.3 If observations indicate cow flow on the track is less than ideal, take action

- Identify and fix areas of the track that interfere with ideal cow flow and cause congestion:
  sharp bends, narrow sections of the track, broken sections of the track where coarse base material is exposed, wet and poorly drained areas, water troughs on the edge of the track, excessively crowned tracks, shaded areas of the track that are slow to dry, live electric fences, stray electricity, excessively steep sections, creek and river crossings, and broken or slippery concrete.

11.4 Observe cow flow into the yard

- Cows should flow smoothly from the track into the yard, settle, wait, and then move smoothly into the milking bails.

11.5 If constructing a new yard or if observations indicate cow flow into the yard is less than ideal, check for high risk factors and rectify.

- Make sure the entrance gate is the same width as the track.
- The backing gate should not be frightening, with no electrified wires. There should be a hock rail on the backing gate.
- The yard should be large enough for the number of cows, greater than 1.3 sq m/cow.
- There should be a sufficient area for 3 to 4 cows to line up ready for entry into the bails.
- Feed at least a small quantity of grain in the bails to provide an incentive for cows to move from the paddock to the yard, and from the yard into the bails.
- There should be sufficient cups for the size of the herd so milking time is kept to 1Â½ to 2 hours.
- Front gates should be quick acting to allow for a rapid and smooth exit.
- There should be a direct flow out of the bails and onto the exit track. The exit track should be separate from the entrance track for at least 30 to 50 metres.
- Pipe work should be designed so that it is safe for the cows.
- There should be no stray voltage around the shed.

12. Do not act in a way that causes adverse changes to cow behaviour

- restrictions to ideal cow flow can cause impatience
- impatient human behaviour alters the walking action of cows adversely
- adverse changes to cow walking action increases the risk of lameness

When cows have to walk on a surface that may injure them, for example a track with stones on its surface, or when they approach a restriction to cow flow, for example, a sharp bend in the track, they slow down. The back cows bunch up while the front and dominant middle group negotiate the hazard.

The farmer or farm hand can make a number of responses:

- Stop and wait for the cows to get past the obstacle.
- Call or shout, or encourage a dog to bark.
- Push excessively from behind, or encourage a dog to chase or even bite cows at the rear of the herd.
- Prod or goad aggressively.

If the farmer or farm hand is pushing the cows too aggressively, the following adverse cow behaviour is seen:

- Cows at the back of the herd begin to swap from one side of the track to the other in order to escape from the herd person. In a herd that is allowed to drift, the cows are generally content to follow one another to the milking shed.
- Cows push one another. In a drifting herd, cows very seldom touch one another.
- As the herd bunches up excessively, cows at the back will lift their heads over those in the front. A drifting cow always has her head down, choosing a safe path

Key Point: If a farmer understands these three behavioural responses (and the foot injuries that result from them), and avoids causing them, there will be a sustained reduction in the incidence of lameness in the herd even if the track is in poor condition

Each one of these responses by the cow results in a greater risk of foot injury (see Guideline 9 â€“ adverse changes to cow behaviour, page XX).

During milking, if milking is a pleasant experience for the cows, milkers should not have to come out of the shed to encourage cows into the bails.

However, if milking is unpleasant, or the farmer is impatient, farmers or farm hands can react in a number of ways to get cows to enter the milking shed from the yard more quickly:

- Enter the yard to force cows into the bales.
- Use an electric backing gate.
- Use a barking or biting dog.

The cows display adverse behaviour and many mill around the yard, pushing against one another and lifting their heads. They have less control over hoof placement, and risk hoof wear and damage.

Again, if a farmer understands these three behavioural responses (and the foot injuries that result from them), and avoids causing them, there will be a sustained reduction in the incidence of lameness in the herd.

12.1 Do not act in a way that causes adverse changes to cow behaviour

- If a herd slows down to get past a poor quality walking surface or a restriction to cow flow, wait for them to negotiate the obstacle in their own time, or shout, or get a dog to bark without pushing the rear cows.
- Do not use a dog that bites

- Do not push or prod in a manner that causes cows to push against one another, or lift their heads over the back of other cows.
- Do not enter the yard to push the cows into the shed.
- Do not use an electrified backing gate or dog. The backing gate should be used only to take up space, never to push.
- If a herd is slow to enter the milking shed, consider using a small quantity of grain as an inducement.

12.2 Fix the poor quality walking surface or eliminate the obstruction that restricts ideal cow flow.

- If you see adverse walking actions and behaviour, follow Guidelines 10, 11 and 13 immediately.

13. Control moisture and wetness in the cow's environment

- hooves soften with prolonged moisture or wetness
- soft hooves are more prone to lameness
- prolonged moisture or wetness increases the risk of footrot
- construct and maintain milking sheds, yards and tracks to control wetness
- reduce moisture in paddocks

Numerous studies have shown that the risk of lameness increases during and after wet weather. Cattle hooves are made of a protein called keratin, which softens when it absorbs moisture through prolonged wetness. To observe this fact, compare the hardness of hoof material when using a hoof knife to scrape a cow's sole during a long dry period compared to that of a sole exposed to a period of prolonged wetness.

Soft hooves are more prone to lameness:

- They wear more quickly. Increased wear causes thinner soles that are more susceptible to puncture or bruising, and severe wear exposes the sensitive corium at the point of the toe. Worn out toes are a special problem for heifers after their arrival in the herd, and for bulls serving a large number of cows on concrete yards.
- Soft hooves are more easily punctured. For example, the sharp edge of a stone can cut right through a soft sole, and introduce infection to the corium. Because the hoof is soft, but still thick, infection is trapped under the sole and causes an abscess.
- A soft hoof provides less protection against stones or broken concrete, so the sensitive hoof-growth area can be easily bruised.
- A wet, soft hoof is more likely to develop fine cracks along the white line when stressed by turning or being placed on uneven surfaces. The hoof wall can bend away from the sole more readily, allowing the defects and cracks to develop in the white line. These cracks can carry infection to the corium, and lead to foot abscesses.
- In wet conditions, small defects that were present in the hoof and which caused no problem during dry periods provide an avenue for infections to enter the hoof, and this may result in foot abscesses.

Moist conditions also soften the skin between the claws and favour survival of the bacteria which cause footrot, making infection more likely.

13.1 If constructing tracks, plan to control wetness

- make sure the surface (or wearing course) prevents seepage of water through to the base. Compact the materials used into a hard, smooth, wear-resistant top. Compacted material should prevent the passage of surface water through into the base material. Cows are not able to compact surface material adequately.
- check the base is above the water table.
- crown the track to help shed water and maintain a relatively smooth surface.
- construct drains outside the fence line to prevent cows walking in the drains. Make sure drains are correctly graded so that water flows away from the track.

13.2 Maintain tracks to control excessive moisture

- avoid wetting the farm track â€“ leaking troughs, irrigation delvers and irrigation run-off can add moisture to the track and cause the surface to break up.
- if trees or hedges near the track prevent sunlight and wind drying shaded areas, remove them.
- if the surface deteriorates, make sure you reform it when weather permits.
- if grass or manure builds up along the fence line, remove it to allow drainage.

13.3 If constructing milking sheds, control water flow in the yard and at the track/yard junction

- build a concrete nib wall at the junction of the concrete and track to divert water to side drains. Otherwise, the junction between the concrete and the track is often a wet area because of drainage of rainwater and yard washings onto the track.
- make sure the flow of cows onto the yard and into the shed is unhindered by any unpleasant experience or factor. If cows stop before the junction because conditions in the yard are unfavourable to them, they manure in this area and add to the problem.
- crown, compact and drain the track at the junction with the yard.

13.4 Maintain milking shed yards to avoid wet areas

- wash the yard twice daily to avoid the build up of slurry.
- make sure yard drainage systems are operational so that cows do not have to stand in water.
- maintain yard concrete surfaces so puddles or water-filled holes do not develop.

13.5 If building calving pads, feed pads and stand-off areas

- check that calving pads, feed pads and stand-off areas are drained correctly, and that drainage water has somewhere to go. Discuss all aspects of drainage with your contractor prior to construction.

13.6 Maintain calving pads and feed pads

- calving pads should be sufficiently dry that no water collects in footprints made with a gumboot.
- scrape feed pads and stand-off areas regularly to prevent the build up of slurry.

13.7 Reduce moisture in paddocks

- elevate troughs and provide a compacted crown for the cows to stand on while drinking.
- fix leaking troughs as soon as possible
- areas around the entrance to paddocks can become worn and retain water. Such areas should be filled in and maintained as required.
- on flat, low-lying farms drainage systems may need to be installed to prevent pasture damage and soft hooves.

14. In an outbreak of footrot, reduce bacterial contamination of the environment

- treat cases of footrot promptly
- isolate cases of footrot
- prolonged moisture or wetness increases the risk of footrot
- reduce moisture in the environment
- consider the use of footbaths

Reducing the number of bacteria in the cow's environment is an effective way of limiting an outbreak of an infectious disease such as footrot. If the skin between the claws is broken, a high level of bacteria is more likely to lead to infection than a low level.

Limiting the risk of injury to the skin between the claws is also an effective method of controlling an outbreak of footrot.

14.1 Reduce contamination of the environment

- Treat cases promptly and effectively (see Guideline 3).
- Isolate cases of footrot. Keep infected animals close to the milking shed so that the spread of bacterial onto the track and around troughs etc is limited.
- Consider the use of footbaths (see Factsheet N).

14.2 Limit potential injury to the skin between the claws

- Control excessive moisture and wetness in the cow's environment (see Guideline 13).
- Limit potential injury to the skin of the interdigital space (between the claws). Reduce the number of stones in the environment (see Guideline 10, Construct and maintain tracks and yards with high quality walking surfaces). Remove the herd from crop stubble if present.

15. Avoid nutritional imbalances

- excess levels of rapidly fermentable carbohydrate leads to laminitis
- subclinical laminitis increases the risk of lameness
- balance high levels of concentrates with adequate levels of fibre
- monitor copper and zinc levels

The effect of excess levels of rapidly fermentable concentrates, especially in the presence of inadequate levels of fibre, is discussed in the Factsheet E, Laminitis. Strategies to minimise the risk of laminitis are also outlined in this section.

The trace minerals copper and zinc are both needed by cattle for the production of good quality keratin or hoof material. Good quality hoof material in turn, is required to withstand the wear and tear placed on hooves. However the effect of marginal deficiencies in the level of either mineral is controversial.

15.1 Control the levels of fibre and concentrate in the diet of lactating and dry cows

The following points are guidelines for pasture-based systems.

- If not experienced in feeding high levels of grain, seek the expert advice of a dairy veterinarian, consultant or nutritionist.
- Introduce animals to concentrates slowly. The level of concentrate feeding should be increased gradually by around 1 kg every second day. Make all feed changes slowly! As a rule of thumb, change no more than 10% of the diet in a four day period.
- If cows are to be fed concentrates immediately after calving, provide a concentrate ration 2 weeks before calving, with cows receiving concentrate up to 0.5 to 0.75% of bodyweight, or 2.5 to 3.7 kgs per cow per day.
- To avoid milk fever, do not feed sodium bicarbonate or legume-based fodders in the late dry period.
- If more than 3 kg of concentrate per cow per day is to be fed, consider using additives such as buffers (for example, limestone or sodium bicarbonate at a rate of one and a half percent) and alkalysing agents (for example, magnesium oxide) to the concentrate portion of the ration. (There is not strong evidence that sodium bicarbonate is effective in cows on pasture.)

Consider using Virginiamycin, an additive registered for the control of acidosis in the diet. There may be some benefit from the use of sodium monensin in controlling acidosis, although there is no product claim for this effect.

- At times of lush pasture growth (when the carbohydrate and crude protein content of the pasture is likely to be very high,) it may be necessary to supplement cattle with fibre. This can be supplied by having cereal hay available for the grazing animals.
- Make sure that crushing of grain is not excessive. Grains such as wheat, barley and triticale should be fractured into 2-5 pieces or be rolled. Corn can be broken into 5-7 pieces or be rolled. Production of fine powdered grain increases the risk of acidosis.
- Check feeders during milking to make sure that feed is not building up in them, and that cows are eating consistently.

The following points are guidelines for producers feeding very high levels of concentrates, and those working in near feedlot situations. (Producers should consult their advisor or nutritionist to help formulate a ration that will minimise the risk of rumen acidosis and laminitis.)

- Make sure the minimum fibre and fodder needs are met. Know the NDF (Neutral Detergent Fibre) levels of fodders used.

For high producing cows, formulate rations to contain at least 23% NDF from fodder. The minimum quantity of fodder as a percentage of dry matter intake should be calculated on hay crop fodder-based rations.

$$\text{Min. fodder DMI\%} = \frac{23 \times 100}{\text{Fodder NDF}}$$

This results in a minimum percentage of fodder in the ration dry matter ranging from 65% with low fibre (35% NDF) fodders to 40% with high fibre (55% NDF) fodders. Therefore the minimum quantity of fodder alters according to the percentage of NDF in the fodder, and should be no less than 40 to 45%.

The total ration NDF should be 27 to 34%.

- Do not exceed 36 to 38% Non Structural Carbohydrate (NSC) in the ration, depending on the grain source.
- If silage is chopped, 25% of the particles on a weight basis should be more than 5 cm long. If silage is chopped too finely, consider feeding 2.5 to 4.5 kg of long or coarsely chopped hay per cow daily.
- Supplement with dietary buffers early in lactation. The recommended feeding rate of sodium bicarbonate is 0.75 to 1% of the total ration dry matter. Sodium bicarbonate is effective for maize silage based diets in providing some control of acidosis.
- Closely monitor changes in fodder moisture content and adjust rations accordingly.
- Do not feed more than 4 kgs of concentrate at one time.
- Ideally, if concentrates and fodders are fed separately, feed concentrates at least three to four times daily.
- Ideally, gradually increase concentrate intake during the first 6 weeks of lactation.
- Consider using Virginiamycin, an additive registered for the control of acidosis in the diet. There may be some benefit from the use of sodium monensin in controlling acidosis, although there is no product claim for this effect.

15.2 Control the levels of the essential trace minerals copper and zinc in the diet of lactating and dry cows

- It is advisable to check the existing levels of both these trace minerals in the diet and in the animals themselves, and establish a need for additional quantities, prior to supplementation. Copper is required at the level of 10 mg/kg of Dry Matter in the diet of cattle, and Zinc is required at 40 to 50 mg per kg of Dry Matter.
- Blood test animals to check the levels of copper and zinc. Establish a need for supplementation prior to addition of trace minerals in the diet. In particular, copper has a small margin between recommended levels, and those that are toxic or poisonous. Animals with satisfactory levels of copper may be poisoned with a copper supplement.
- Seek expert advice about when to assess herd copper levels, and about the interpretation of the results of tests. The levels of copper may vary month to month.
- Zinc deficiency has been implicated in lameness in dairy cattle. Zinc is important in claw horn formation and is present in reduced quantities in the horn of cattle with claw lesions. Supplementation with a zinc derivative, zinc methionate, has been demonstrated in several trials to reduce the incidence of hoof abnormalities.

16. Consider the conformation of bulls and cows used for breeding herd replacements

- good conformation reduces the risk of lameness
- breeding for "lameness resistance" a complex issue
- desirable traits may have low heritability

It is well known that the size and shape of an animal - its conformation - has a strong bearing on its ability to remain healthy in its particular environment.

To a certain extent, managers are able to influence the size and shape of their animals as many characteristics are heritable.

Genetic selection or breeding towards a certain shape may make progeny more hardy and resistant to disorders that cause lameness, and therefore less likely to be culled due to foot disease, or infertility or body weight loss related to lameness.

A number of issues add complexity to the goal of breeding "lameness resistant" animals:

- Some desirable traits have a relatively low hertiability.
- Assessing the conformation of animals with consistency and accuracy requires experience and skill.
- Assessment does not necessarily mean measurement, and therefore grading can be subjective.
- Management can affect measurements; for example, claw length can be altered by trimming.
- Foot disorders can affect measurements; for example an episode of laminitis can increase claw length.
- Claw measurements can be affected by age; for example, length may increase with age, and hoof angle may decrease with age.
- Even posture can affect measurements; the way an animal stands may alter scoring.

Further research into this area is required before strong recommendations are made with respect to selection for traits to reduce the incidence of lameness.

The following table is presented as an indication of current opinion regarding traits most likely to affect survivability and to have sufficient heritability (if selected in a breeding program) to result in improvement of progeny.

Trait	Scoring	Desirable
Claw angle	Low to high	High (>45^{o} to 60^{o})
Rear leg, side view	Posty to sickled	Intermediate
Rear leg, rear view	Close to straight	Straight

from Lamenes in Cattle (1997), Greenough and Weaver, Saunders.

In addition, research has indicated that:

- Breeding for production alone may select traits that make an animal more prone to lameness.
- Friesians are more prone to damage than other dairy breeds.
- White or less pigmented hooves (found most commonly in Friesians) are softer and more prone to damage.

16.1 Consider the conformation of bulls and cows used for breeding herd replacements

Do not breed from cows that show marked conformation faults that:

- increase the risk of lameness and
- are sufficiently heritable to result in significant genetic deterioration.

At the time of writing, it is thought that the characteristics most likely to influence the incidence of lameness are:

- Claw angle: Less than 45 degrees or higher than 60 degrees is undesirable. 45 degrees to 60 degrees is desirable.
- Rear leg, side view: Excessively posty or sickled legged is undesirable. Intermediate angulation is desirable. A hock angle of less than 170 degrees is desirable.
- Rear leg, rear view: Cow hocked or close is undesirable. Straight legged is desirable.

It is a recommendation of the authors that artificial breeding companies investigate the production of an ABV for lameness.

Factsheets

A. Identifying, treating, and preventing footrot.

- bacterial disease spread cow to cow
- infection usually introduced via damaged skin between the claws
- causes a swelling in the area above the hooves
- responds to antibiotics if treated early

Footrot is one of the most common causes of lameness in dairy cattle. It is an infection of the foot caused by bacteria which usually live in the soil. The bacteria enter the tissue of the foot through abrasions, cuts or wounds in the skin.

The disease is often seen in high rainfall regions, or in areas that are continually damp or wet, for example calving pads or feedlots. Moisture softens skin which is then prone to injury, and infection follows. Moisture and warmth also favour the survival of the bacteria in the soil.

The gap or cleft between the two claws is the usual place for infection to start. The cleft is narrow and tight, so stones, sticks and other objects lodge easily, eventually causing a break in the skin, and an entry point for infection.

Once footrot bacteria have penetrated the skin and invaded the foot, they multiply and produce toxins or poisons which damage the area under the broken skin. The signs of inflammation â€“ pain, lameness, redness, swelling and heat are the result.

The appearance of footrot

- Lameness is usually sudden and severe. The cow may even develop a slight temperature, and a drop in milk production. Bulls with footrot can suffer lowered fertility.
- The area just above the hoof (the coronet) swells. The two claws spread apart. The skin becomes warm, tight and reddened. There's often a split in the skin at the top of the cleft. This split can be at the front, the rear, or all the way along the cleft. The skin edges along the split are swollen. Within the split there is usually dead tissue and very foul-smelling pus.
- Footrot can occur without this split in the skin, and then the only signs of disease you see are lameness, severe swelling, redness and heat.
- Severe infections of footrot can extend beyond the cleft and invade the joints of the foot, or run up the outside of the tendons to infect the upper leg. Then the swelling is massive and disabling. In these cases, the disease has the potential to cause loss of the leg, and so, loss of the animal.

How footrot spreads

- When infected material leaks out from the foot of an animal with footrot and mixes with the soil, it introduces millions of bacteria into the dirt and ground surfaces of your farm, ready to infect other animals. In other words, the infection spreads from cow to cow via the soil.

Treating footrot

- Prompt treatment is essential. Infections become severe if left untreated.
- Although it may be unpleasant to do so, it is necessary to explore the split between the claws with your finger to check for buried stones, sticks or other foreign objects. A yellow core of dead tissue is sometimes easy to remove.
- Once the cleft has been cleaned and checked, it can be sprayed with a disinfectant.
- Intramuscular antibiotics such as penicillin, tetracyclines, or sulpha drugs are usually an effective treatment. A three day course is recommended so that all traces of bacteria are killed while the split heals. Make sure milk and meat withhold times are observed.

Prevention of footrot

- Reduce stones in the environment with appropriate track maintenance. Unstable areas should be repaired.
- Reduce moisture in the environment. Drain muddy areas. Maintain tracks, areas around drinking troughs, gateways and drains. Make sure calving pads have a proper drainage system when installed.
- Rapid treatment and isolation of infected animals limits the spread of bacteria around a farm. Often a prolonged dry period is needed to reduce the numbers of bacteria within the soil.
- Footbaths with chemicals such as copper sulphate or formaldehyde are supposed to harden hooves, and kill bacteria on the skin surface in the cleft of normal animals.

However the chemicals within footbaths are easily contaminated and diluted with mud and manure. In addition, if hooves are already muddy, the chemicals may not penetrate to the hoof and skin between the cleft. Also, as cows walk out into wet areas, the chemicals can be quickly washed off the foot. So the use of footbaths is debatable.

The chemicals are dangerous to you and the environment, so seek professional advice before their use.

See Factsheet M for further information about the use of footbaths.

B. Identifying, treating, and preventing bruised soles.

- caused by excess pressure on uneven ground, especially on stones.
- many factors increase the risk
- causes pain within the claw and lameness
- responds to rest

Inside the hard, outer layer of hoof wall and sole, a cow has a sensitive layer of tissue rich in blood vessels and nerves. This layer is almost identical to the quick of our own fingernails and toenails. Just as you can get a 'black' fingernail or toenail when you hit or squeeze it, cows can bruise their hooves.

If a cow stands on a stone, its sole bends upwards, over the stone. The sensitive layer is severely squeezed between the sole and the pedal bone within the foot pressing downwards, with the weight of the cow above it. (The sensitive layer is caught between a rock and a hard place!)

The resulting damage caused bleeding within the claw, and subsequently pressure, pain and lameness.

The appearance of bruised soles

- To identify bruising, the surface of the sole has to be very well cleaned with a knife, rasp or sanding disc.
- Pink, red or dark red flecks appear in the surface of the sole. This flecking is stale blood growing through the hoof from the damaged sensitive layer. It is similar to the appearance of your finger- or toenails when they turn 'black' from damage.

The multiple causes of bruised soles

A number of factors contribute to an increased risk of bruising.

- If many stones are present on the track or in the yard, there is an increased risk of bruising. Damage is more likely if the stones are free on the surface rather than buried, if they are sharp rather than rounded, and if the surface beneath them is concrete or very hard ground.

If a track 'breaks up', and stones from the track base are brought to the surface, clearly there is an increased risk of bruised soles.

- If the hoof is soft due to very moist or wet conditions, it distorts more easily over a stone and offers less protection to the sensitive layer, and therefore is more prone to bruising.
- If the sole is thin due to excessive wear, it will offer less protection to the damage caused by stones. Excess wear can be caused by abrasive sand carried into the yard, from newly poured concrete, from excessive turning of cows in the yard when on heat, when heifers are bullied by older and more dominant cows, or when the farm operator tries to hurry cows into the milking shed.
- Driving or pushing cows along a track or into an already crowded yard can result in a cow lifting her head and placing her feet in an unplanned manner. She is then more likely to step on a stone and cause bruising.
- Poor hoof shape or conformation can cause excess hoof under the sole. Then the normal pressure of walking may be sufficient to cause bruising and lameness.

Multiple causes of bruising can be present at the one time. For example, winter is a common time for excessive moisture, and for tracks to break up, which in turn may result in a herd being driven. Thin soles may be simultaneously present in young animals.

Treating bruised soles

- Draft cows with bruised soles into a paddock close to the shed at milking time. Bruising will repair with time, but rest is important. Walking long distances can lead to additional bruising. Make sure cows don't have to walk far for food or milking.
- Particularly severe bruises may need some form of relief from the pressure of body weight and walking. A glue-on plastic shoe can be fitted (if bruising is largely confined to one claw) or a shoof applied (if severe bruising is present in both claws).

- f the sole is excessively thickened, it will require corrective trimming.

Prevention of bruising

- Reduce stones in the environment with appropriate track maintenance. Unstable areas should be repaired. Properly constructed and maintained tracks can reduce the incidence of bruised soles.
- Reduce moisture in the environment. Drain muddy areas. Maintain tracks, areas around troughs, gateways and drains. Make sure calving pads have a proper drainage system when installed.
- Avoid conditions which cause excessive wear of soles, such as the presence of abrasive sand in the yard.
- Use good stockmanship when getting the cows in for milking, or moving them.
- Keep hooves in good shape with corrective trimming if necessary. However, trimming may reduce sole thickness, and is best avoided when animals have to walk long distances to pasture. Sufficient sole thickness must be left to allow for reasonable protection. Hooves can be trimmed at drying off when cows have a rest from walking long distances.

C. Identifying, treating, and preventing white line disease.

- the white line is the fibrous join between the wall and the sole
- it is a point of weakness
- in white line disease, the fibrous junction disintegrates and is penetrated by debris
- the resulting cracks can extend into the claw to cause an abscess

What is the white line? The hoof of the cow is divided into two main areas - the wall (which is the visible outer part of the claw), and the sole (which is the undersurface of the claw). The cow actually bears most of her weight on the wall. The fibrous join between the wall and the sole is called the white line.

If you clean the undersurface of the hoof, and then smooth it with a knife, rasp or sanding disc, you can see the join, and it is indeed a white line.

The join is weaker than either the wall or sole, and this results in the white line being a focal area for development of lameness.

If the quality of the keratin is poor or soft following laminitis, or if the hoof wall is stressed by cows carelessly placing their feet or twisting excessively, or if feet are poorly shaped, small cracks can occur in the white line.

The cracks cause lameness when they extend deeply into the hoof and reach the sensitive area of the foot. There the cracks allow bacteria into a site rich in blood vessels, but poorly drained. A hoof abscess develops in the confined area of the claw, and pain and lameness result. The abscess results in a cavity within the hoof, 'an underrun sole', or an underrun wall, which may discharge at the coronary band.

The appearance of white line disease

- To identify white line disease, the surface of the sole has to be very well cleaned with a knife, rasp or sanding disc.
- Small cracks usually occur along the white line, towards the heel, but may be anywhere between the heel and the point of the toe. They first appear as diagonal black lines crossing the white line. Then they can pack with dirt and gravel, and slowly enlarge until the wall and the sole begin to separate.

The causes of white line disease

A number of factors contribute to an increased risk of white line disease.

- Driving or pushing cows along a track or into an already crowded yard can result in a cow lifting her head and placing her feet in an unplanned manner. She is then more likely to step on stones or uneven ground and stress the white line. Other stresses on the white line can result from excessive turning of cows in the yard when on heat, or when new additions to the herd or heifers are bullied by dominant or older cows.
- If a track 'breaks up', and sand or gravel is carried onto the yard, the white line can pack with the sand or gravel, increasing the risk of abscesses developing.
- The sharp edges of concrete on poorly maintained yards can stress the white line.
- If the hoof is soft due to very moist or wet conditions, the white line offers less resistance, and cracks develop more easily.
- If the sole is thin due to excessive wear, the white line will be thinner, and less able to resist stress.
- Poor hoof shape or conformation can cause packing of gravel under the sole, and eventual penetration and separation of the white line.
- Poor hoof material quality caused by subclinical laminitis can make the white line weaker, and therefore, more prone to cracking. In addition, chronic laminitis causes the normal shape of the hoof to distort, making it more prone to white line disease.

Treating white line disease

- Pare out the fine cracks between the wall and the sole with a hoof knife or sanding disc attached to an angle grinder. Pare the wall away in a shallow 'V' so sand or gravel does not pack into the pared area.
- The cracks can extend into the sensitive area of the hoof, and cause an abscess. If this is the case, pus will escape onto the pared area (see treatment of underrun soles,).
- Where white line disease has resulted in an abscess draining to the coronary band, it is necessary to remove part of the wall of the hoof over the defect.
- If the paring results in removal of a significant portion of the wall and sole, apply a cowslip to the unaffected claw to relieve pain and prevent further white line disease.

Prevention of white line disease

- Use good stockmanship when getting the cows in for milking, or moving them. Pushing stock stresses the white line.
- Maintain tracks to reduce sand and gravel in the environment. Unstable areas should be repaired.
- Maintain the concrete in the shed, yard, and concreted areas of tracks.
- Reduce moisture in the environment. Maintain drains to reduce muddy areas.
- Avoid conditions which cause excessive wear of soles, such as the presence of abrasive sand in the yard.
- Keep hooves in good shape with corrective trimming if necessary.
- If feeding concentrates, avoid subclinical laminitis and maintain high quality hoof material with well-balanced rations.

D. Identifying, treating, and preventing underrun soles.

- a cavity between the sole and the deeper, sensitive layer
- source of severe pain and lameness, even during healing
- drain promptly
- protect the new sole horn while healing

Any crack or puncture in cow's hooves can penetrate to the sensitive area. Dirt and gravel carry bacteria into the sensitive hoof-growth area. There the bacteria multiply and produce toxins or poisons. White cells move into the area from blood vessels to defend the foot against infection.

Damaged or dead white cells killed by bacteria release chemicals that produce the signs of inflammation - pain and lameness, redness, swelling and heat. This causes significant problems for the cow.

Firstly, because the infection is within the hoof, often the redness and swelling is not easy to observe. The signs of disease are hidden. In addition, unless the foot is lifted and cleaned, the crack or puncture and resulting infection remains undetected and the cows pain continues unrelieved.

Secondly, infection eventually leads to a fluid of dead bacteria and white cells '“ pus. Because the hoof provides a hard exterior case'□, the fluid cant escape. It builds up and causes pressure. This results in intense pain, and severe lameness results.

Finally, because the pus cannot escape, it builds up until it separates the sole from the sensitive area, forming a cavity. The cavity enlarges until usually, the pus bursts out - often at the heel - where the hoof joins the skin. The process of cavity formation causes a portion or the entire sole to lift from the deeper layer - a disease called underrun sole. The process results in severe foot damage.

If the infection does burst out at the heel, the cavity at the heel is free to pack with dirt and gravel between the sole and the sensitive layer, and cause more pain.

Alternatively, the infection may not burst out at the heel, and (like footrot), may penetrate deeper areas of the foot, infecting tendons and joints. Loss of the claw and in severe cases, loss of the cow may result.

White line disease is a common cause of penetrations that cause underrun soles. Hooves with thin soles that are the result of hoof wear are more susceptible to injury and penetration. Large pieces of gravel or the sharp edges of stones can puncture the sole, and introduce bacteria. Gravel can slowly pack into uneven or damaged areas of sole or wall, and can be forced through to the sensitive hoof-growth area. Nails and other objects can perforate the hoof and cause an underrun sole.

While many cases of underrun soles are caused by cracks in the white line towards the heel area, the point of the toe is also prone to developing fine cracks that lead to very painful 'point of toe'□ abscesses.

Very small defects in the sole of the hoof may be sufficient to allow bacteria into the underlying soft tissue, resulting in infection and pus building up within the hoof.

The appearance of underrun soles

- Often lameness is the only outward sign of underrun soles. The resulting lameness may be very severe, with cattle showing a characteristic 'sliding'□ lameness.
- The bulb of the heel on the side of the affected claw can swell and redden in response to the infection. Occasionally the infection can extend to deeper areas of the foot, and even into joints or tendon sheaths. Then the pain, swelling and redness are very severe.
- If the pus under pressure escapes to the outside, the exit area can be seen as a gap between the hoof and the skin. Often the gap appears at the heel where the hoof thins. On other occasions the pus can exit between the claws or on the coronet towards the heel.
- Hoof testers can be used to help determine which claw is affected, and the area of greatest pain. This is the area which requires very careful examination.
- If the foot is correctly cleaned and examined, with careful examination the crack or puncture responsible can be found on the white line or sole. If followed into the hoof as far as the sensitive area, pus will eventually escape or the cavity will be sighted. Drainage can be established by widening the hole.

The causes of underrun soles

Because white line disease and excessive hoof wear are major causes of underrun soles, the factors that cause white line disease and excessive hoof wear are also responsible for causing underrun soles.

- Driving or pushing cows along a track or into an already crowded yard, excessive turning of cows in the yard when on heat, or when new additions to the herd or heifers are bullied by dominant or older cows all cause white line disease and resultant underrun soles.
- If a track breaks up'□, and sand or gravel is carried onto the yard, the white line can pack with the sand or gravel, increasing the risk of underrun soles.
- In addition, when a track breaks up, stones are brought to the surface and can penetrate the sole, especially if the track under them is hard, or they are carried onto the hard surface of concrete in a yard.
- The sharp edges of concrete on poorly maintained yards can stress the white line or cause the sole to be cut or punctured.
- If the hoof is soft due to very moist or wet conditions, the white line offers less resistance stresses, and cracks develop more easily. In addition, the sole is softer too, offering less resistance to penetration by sharp stones.
- If the sole is thin due to excessive wear, the white line and the sole will be thinner, and less able to resist penetration.
- Poor hoof shape or conformation can cause white line disease, and subsequently underrun soles.
- Poor hoof material quality caused by laminitis, and abnormal hoof shape caused by chronic laminitis can lead to white line disease, and the development of underrun soles.

Treating underrun soles

- Prompt treatment is essential to prevent the underrun area getting larger, or infection entering deeper areas of the foot.
- Pare out fine cracks between the wall and the sole with a hoof knife or sanding disc attached to an angle grinder. Pare the wall away in a shallow V'□ so sand or gravel does not pack into the pared area.
- The cracks that cause an underrun sole can be so fine that they are difficult or impossible to see. Look closely at the hoof to discover them, or apply pressure with hoof testers to squeeze moisture out of fine cracks to aid detection.
- If drainage is established very early in the course of the infection, pus may not be present, or the quantity may be very small. If this is the case, the hole made by exploration may be sufficient allow drainage and prevent a cavity forming, and an underrun sole developing.
- Once pus is found, or cavity sighted, make the drainage hole made larger to allow pus to drain freely. Care is required. Do not cut the sensitive layer of the hoof, and start bleeding.
- Carefully cut away all underrun areas of hoof with a hoof knife or hoof cutters if you are sufficiently experienced. Where possible, leave sound sole and wall for the cow to walk on. On occasions, the whole sole is underrun, and should be removed. Again, do not cut the sensitive layer of the hoof, and start bleeding. Failure to remove the entire underrun area risks further packing with sand and gravel, and continuation of the condition. Delayed or poor treatment of underrun soles can result in a second layer of infection under the initial underrun area, a condition called double underrun sole.'□
- If you lack the experience to do this, call your veterinarian so that the condition can be treated professionally.
- Because the sensitive sole is no longer protected by hoof material, protect it to prevent pain, and allow the cow to graze, eat supplements if offered, and express normal behaviour such as bulling. Apply a cowslip to the other claw (see Factsheet O), or apply a shoof to the foot if both claws are affected (see Factsheet O). It may be necessary to dress the affected claw with a temporary bandage to prevent further damage or pain from stones or uneven concrete.

- Because it takes time for a new sole to grow and replace the underrun area, lameness can persist for some weeks after drainage. Appropriate protection (above) minimises lameness and its side-effects during the long healing phase.

Prevention of underrun soles

- Use good stockmanship when getting the cows in for milking, or moving them. Pushing stock stresses the white line.
- Maintain tracks to reduce sand, gravel and stones in the environment. Unstable areas should be repaired.
- Remove stones from the surface of the track and yards.
- Maintain the concrete in the shed, yard, and concreted areas of tracks. Repair broken edges.
- Reduce moisture in the environment. Maintain drains to reduce muddy areas.
- Avoid conditions that cause excessive wear of soles, such as the presence of abrasive sand in the yard.
- Keep hooves in good shape with corrective trimming if necessary.
- If feeding concentrates, avoid laminitis and maintain high quality hoof material with well-balanced rations.

E. Identifying, treating, and preventing laminitis.

- inflammation of the corium
- 3 phases - subclinical, acute and chronic.
- causes a reduction in the quantity and quality of hoof material.
- aspects of nutrition, exercise, trauma and concussion are important causes
- laminitis is an important cause of other foot diseases

Laminitis is inflammation of the corium - the soft tissue between the hoof walls/sole on the outside of claw, and the pedal bone within the claw. This area is rich in fine blood vessels and nerves, and is responsible for normal growth of the walls and sole. Severe inflammation results in a reduction in the quantity and quality of keratin or hoof material produced.

There are three phases of laminitis - subclinical, acute (and subacute), and chronic. Each phase has a typical appearance and is an important cause of lameness.

The typical signs of inflammation - redness, swelling, heat, pain, and loss of function (lameness) - are present during a case of acute laminitis.

In pasture fed, concentrate supplemented dairy cattle, subclinical laminitis occurs much more commonly than acute laminitis.

Because laminitis interferes with the production of healthy hoof wall and sole, it is an important cause of other hoof diseases and the lameness that they cause, for example, white line disease, sole abscess, sole ulcer and claw deformities.

The appearance of laminitis

- The signs of acute and subacute (less severe) laminitis appear quickly. Cases show the typical signs of inflammation. The coronary band becomes reddened and warm. Increased blood flow may be detected by the findings of increased pulse and engorgement of the veins of the hindlimb. Although the tight skin around the coronet and the relatively inflexible walls of the hoof do not permit a great amount of swelling, it is present (even if only on a microscopic scale). Acute and subacute forms of laminitis are not common in cattle, and are often seen following accidental engorgement of large quantities of grain.
  The pain causes cows to change the way they stand. Laminitis often causes lameness affecting more than one limb at a time. Often the hindlegs are positioned forward under the animal ("camped forward"). A cross-legged stance may develop.
- In chronic laminitis, the claw changes shape. It becomes longer, and the front wall of the hoof is concave when viewed from the side. The sole becomes flatter and wider. The wall develops horizontal ridges or ripples due to partial interruptions in its production. The claw is more prone to develop sole bruises, white line disease, sole abscesses, sole ulcer and claw deformities such as slipper foot. Lameness is often due to these secondary diseases.
- Subclinical laminitis produces no immediate signs, but is recognised by the changes in the hooves which occurs several months after episodes of subclinical laminitis. The changes are recognised as deterioration in hoof horn quality and haemorrhages in the sole of the hoof. It is often necessary for the surface of the sole to be lightly sanded or scraped for the changes to be readily observed.
  The white line develops a yellow colour and has small red dots of haemorrhage along it. The sole also becomes yellowish and develops flecks of haemorrhage within it. The hoof material appears waxy and is softer. In cows affected by laminitis, other foot diseases are found more commonly - white line disease, sole abscess, sole ulcer and claw deformities.
- When a whole herd is affected, many cows can become reluctant to walk. A herd that normally travels willingly to and from the milking shed to pasture may slow down and become extremely difficult to move in the normal fashion.

The causes of laminitis

- The sudden introduction or unbalanced feeding of high levels of rapidly fermentable carbohydrates such as grain may cause laminitis. Such feeding practices increase volatile fatty acids production by bacteria in the rumen, and pH falls. The acidity kills beneficial bacteria and other microorganisms,

and they are replaced by bacteria that produce further acids â€“ especially lactic acid. Rumen pH falls to critically low levels. This condition is called acidosis.
When this occurs, the rumen wall absorbs the acids together with poisonous chemicals released by dead bacteria and an additional chemical called histamine. They enter the cows bloodstream and are carried around the body to the feet. There they change blood flow in the blood vessels that supply the corium, the area responsible for hoof growth. This causes inflammation, poor quality hoof production, the signs of laminitis, and lameness.
In severe cases of excess acid production in the rumen, the rumen wall can develop infected ulcers, and bacteria can be carried from the ulcers to the liver where liver abscesses develop. An elevated body temperature, depression and weight loss may follow. Abscesses on the liver may be fatal.
The presence of rumen acidosis can be checked by using a pH metre to measure the acidity of rumen fluid. This should be performed 2 to 5 hours after the feeding of concentrates, or 5 to 8 hours after the feeding of a Total Mixed Ration.

- Diets low in fibre, especially when fibre length is short and relatively ineffective, can increase the risk of acidosis. Low fibre diets reduce cud chewing, in turn decreasing saliva production. Saliva is high in bicarbonate that acts to buffer acid production in the rumen. When saliva production is decreased, the capacity to neutralise the excess acids produced in acidosis is reduced.
- It is also thought that excess protein and a relatively low percentage of fibre in rapidly growing, high-quality pasture may cause laminitis.
- Poisons or toxins produced in other diseases such as metritis or mastitis can also cause laminitis.
- Exercise is required for normal hoof health, and a reduction in exercise, especially when associated with unbalanced feeding of high levels of grain, and especially around calving time may increase the risk of laminitis.
- Trauma to soles due to excessive walking or turning, or walking on uneven or stony tracks may cause laminitis or make the diseases that develop secondary to laminitis worse.
- There is a higher risk of laminitis around calving and when other diseases such as acetonaemia, fat cow syndrome and displacement of the abomasum (or fourth stomach) occur.

Opinions regarding the significance of the various causes of laminitis are divided.

Treating laminitis

- If you suspect acute laminitis, call your veterinarian to assist with diagnosis. When acute laminitis occurs, every attempt should be made to identify the cause(s). Pay particular attention to the diet of the cow or herd. It may be advisable to call a veterinarian, nutritionist or consultant to ensure the correct balance of components. More than one factor may be involved.
- Lameness caused by subclinical laminitis may not occur until weeks or months after the episode(s) of laminitis. Treat the secondary diseases caused by subclinical laminitis - such as sole bruises, white line disease, sole abscesses, and sole ulcer - promptly and effectively. (See Factsheets for treatment of these separate conditions.) The possible causes of this subclinical laminitis should be investigated.
- The lengthening of the claw, and broadening and flattening of the sole caused by chronic laminitis leads to claw deformities such as "slipper foot". Deformities should be corrected with hoof trimming to restore or improve foot shape. This requires experience. Call a veterinarian for professional assistance if necessary.

Prevention of laminitis

In Australia, how cows are fed varies widely from State to State, and even between farms in the same district. Pasture remains the predominant source of nutrition, but its quality and quantity can vary widely over the period of a year. Excess quantities of pasture grown in the spring are conserved as silage or hay and fed back as fodder to the cows at a later date.

F. Identifying and treating vertical fissures or "sand cracks"

- uncommon cause of lameness
- easily missed
- treatment difficult

Vertical fissures or so-called "sand cracks" develop as a vertical split in the hoof wall at the front of the claw.

The appearance of an axial groove crack.

- Mud or manure often hides sand cracks, so clean the whole of the claw prior to examining it.
- Sand cracks start at the junction of the coronet and hoof. The split can extend for a variable distance down the wall to the point where the wall contacts the ground surface. They usually occur at the front of the outer claw of the fore feet.
- The depth of the split is also variable. Pain and lameness occurs when the crack extends deeply to reach the corium, and carries dirt and infection into this sensitive area.
- Many animals with sand cracks show no signs of lameness.

Treating sand cracks

- Treatment of sand cracks is difficult, and requires an experienced operator and sometimes, special equipment. If you are not experienced in the treatment of this disease, call your veterinarian.
- Pare out the sand crack with the curled end of a sharp hoof knife, or with a barrel-shaped bit attached to a Dremel drill. In hot and dry conditions, the vertical hoof wall can be very hard, and defeat a hoof knife. If this is the case, an experience operator should use a power tool such as a Dremel drill.
  It is very important not to expose too much of the underlying soft tissue when paring out sand cracks. If a large area of soft tissue is exposed, there is a risk of proud flesh or granulation tissue growing at the site, and this growth is difficult to control.
- If lameness is present, usually the crack can be followed to the sensitive corium at one point along its length.
- Occasionally cracks can start in a vertical direction, and then extend along the claw in a horizontal direction. They can be large and pack with mud. When this occurs, pare out the entire crack.

G. Identifying and treating axial wall cracks

- a diligent search and an expert eye may be required to find axial wall cracks
- treatment difficult
- recovery slow
- retreatment occasionally necessary

Occasionally a crack develops on the inner hoof wall, running from the coronet to the sole. Because the crack is between the two claws, it is not obvious to an inexperienced operator, and can be difficult to treat because it is not very accessible. The technical name for the inner hoof wall is the axial wall, and hence the name axial wall crack when a crack appears in this area.

The crack packs with dirt, and when it extends to the sensitive area of the hoof, it causes pain and lameness, and infection can follow.

In some districts, axial wall cracks are a common cause of lameness.

The appearance of an axial wall crack

- To identify an axial wall crack, the space between the two claws has to be thoroughly cleaned with water and a brush. Large chunks of mud may need to be picked away with a hoof knife first.
- Axial cracks run from the skin/hoof junction at the coronet to the axial groove on the sole, between the two claws, usually closer to the toe than the heel.

Treating axial wall cracks

- Treatment of axial wall cracks is difficult, and requires an experienced operator and sometimes, special equipment. If you are not experienced in the treatment of this disease, call your veterinarian.
- Pare out the axial crack with the curled end of a sharp hoof knife, or with a barrel-shaped bit attached to a Dremel drill. It may be a painful condition, and therefore treatment can be uncomfortable for the animal. If so, call a veterinarian who may decide to use a local anaesthetic.
  It is very important not to expose too much of the underlying soft tissue when paring out sand cracks. If a large area of soft tissue is exposed, there is a risk of proud flesh or granulation tissue growing at the site, and this growth is difficult to control.
- Proud flesh can protrude through the crack either before treatment or develop after treatment. This is a painful condition for the cow as the proud flesh can be squeezed by the hoof walls either side of the crack. The proud flesh should be removed by a veterinarian.
- Occasionally the hoof wall next to the coronet can be underrun with infection, and if this is the case, remove the underrun hoof. If footrot is present as a secondary problem, treat it with antibiotics. Withhold milk and meat as per label instructions.
- Axial wall cracks may take some time to heal, and more than one treatment is sometimes necessary.
- Excessive pain and lameness can occur. Apply a glue-on plastic shoe to the other claw if this is the case.

H. Identifying an interdigital fibroma

- benign growth between the toes
- often infected with footrot bacteria
- surgical removal

Interdigital fibromas are benign growths that are located between the claws of cattle, and are important as they cause lameness. Because they can cause a break in the skin, they can act as a site of entry for the footrot bacteria, and be a cause of footrot.

The appearance of interdigital fibromas

- Interdigital fibromas are easily found and identified during a thorough examination of a lame foot. They appear as a fleshy growth hanging down from the skin between the claws of the foot. Occasionally they can be seen between the claws from the front of a cow or bull when standing.
- If infected with the footrot bacteria, the rest of the foot looks like a typical case of footrot. Occasionally an interdigital fibroma can bleed or be flystruck.
- The degree of lameness caused by these fibromas depends on the size and location of the growth. Small or moderate sized fibromas may persist for years without causing lameness. Larger fibromas with infection or ulceration may cause severe lameness.

Treating interdigital fibromas

- If you identify an interdigital fibroma, call your veterinarian and have the fibroma removed surgically under local anaesthetic. Your veterinarian may apply local treatments and dress the foot.
- Intramuscular antibiotics such as penicillin, terramycin, or sulpha drugs may be given as a follow-up treatment. Make sure milk and meat withhold times are observed.
- Surgical removal is usually a very effective cure.

I. Identifying, treating and preventing hairy heelwarts (digital dermatitis).

- An infectious bacterial disease
- Major cause of lameness in USA, but occurs infrequently in Australia
- Hairy wart-like or ulcer-like sores located on the bulb of the heel
- Responds rapidly to antibiotics applied to the diseased skin

Hairy heelwart or digital dermatitis is a painful, contagious disease causing wart-like areas on the back of the hind feet, on the bulb of the heel or near the interdigital cleft. It was first reported in 1974, and has since been observed in most countries where large numbers of dairy cattle are maintained in drylots.

During the 1990s, hairy heelwart spread throughout dairies in the USA, where it is now a major infectious cause of lameness. Presumably due to dryer conditions and different production systems, hairy heelwart only occurs rarely in Australia. A particularly wet, muddy winter may result in more cases amongst heifers or cows in their second calving.

Hairy heelwarts are caused by bacteria and therefore respond to antibiotic treatment, however the type of bacteria which causes the disease remains unknown. Many types of bacteria have been found in the infected areas. Spirochaetes (cork-screw shaped bacteria) are the most common type.

The appearance of hairy heelwart

- Hairy heelwarts are found after thorough washing of the lame foot. The hind feet are most commonly affected. They may occur on more than one foot including the front feet. The affected area is located on the bulb of the heel at the margin between the hoof and skin (the coronary band). Occasionally it extends into the interdigital cleft or involves the dew claws.
- The infected areas are circular to oval, 2-6 cm in diameter, and surrounded by grey, thickened skin bearing long, erect hairs. They are very painful to touch and prone to bleeding, but there is no swelling or inflammation of the foot.
- Early (ulcerative) sores are moist and red with the appearance of a cut strawberry. As the disease progresses, the sores become grey to whitish yellow, and produce excess tissue with a characteristic wart-like appearance, and long, hair-like projections. The infection is usually chronic, and takes several weeks to heal.
- Cows with hairy heelwart show varying degrees of lameness from none to placing weight on the toes or reluctance to bear weight altogether.

Treating hairy heelwart

- Because hairy heelwart is rarely diagnosed in Australia, it is suggested that you should contact your veterinarian to discuss a suspected case before treatment is undertaken.
- Applying antibiotics to the surface of the infected areas is the most effective form of treatment for hairy heelwart. Intramuscular injections of antibiotics do not result in an effective cure, and are unnecessary.
- Oxytetracycline as a spray applied daily to infected areas at milking, or in soaked gauze applied as a footwrap is most effective.
- Surgical removal can be performed in conjunction with a footwrap for wart-like areas in the interdigital cleft that do not respond to sprays.

Prevention of hairy heelwart

- Reduce moisture in the environment. Drain muddy areas. Maintain tracks, areas around drinking troughs, gateways and drains. Make sure calving pads have a proper drainage system when installed.
- Risk factors that contribute to the occurrence of hairy heelwart in the USA include the use of drylots, the introduction of replacement heifers, failure to quarantine and inspect new stock, the use of hoof trimmers, failure to clean hoof trimming equipment, and grooved concrete flooring.

J. Conditions of the upper leg.

- hip dislocation
- hip arthritis
- rupture of the cruciate ligaments

Although more than 90% of cases of lameness are due to conditions of the foot, disorders do occur in the upper leg, and are often severe and disabling.

Dislocated hip

- The hip joint is a ball and socket joint; the pelvis forming a socket, which cups the ball-shaped head of the thighbone or femur. A ligament from the ball to the socket, and the muscles surrounding the joint, usually prevent dislocation.
- Trauma may cause the ligament to tear, and the ball to dislocate from the socket. Examples of such trauma include service injuries, bulling injuries, slipping in a yard, and struggling to rise if affected by milk fever or calving paralysis.
- Most animals are unable to stand following dislocation of the hip. Some animals may be able to stand, and are usually unable to bear weight on the affected leg, with the leg is rotated so that both the stifle and foot are turned outward.
- Dislocated hips may be relocated successfully in about 50-60% of cases, if treatment is provided within about twelve hours of the injury occurring. The affected animal is usually heavily sedated or anaesthetised, and the leg placed under traction in an attempt to relocate the ball in the socket.
- If the animal is not treated promptly (within twelve hours), the socket can fill with blood and this can prevent successful relocation.
- If hip dislocation is suspected, call your veterinary surgeon to confirm the diagnosis and attempt relocation if the animal's value warrants treatment. The cost of the treatment should be weighed against the likelihood of success. Treatment is more likely to be successful if the animal is young, standing, and if the injury occurred within 12 hours of treatment.
- Occasionally, both hip joints can be dislocated. In these cases, the animal is unable to rise.

Hip arthritis.

- Cattle may develop hip arthritis due to prior injury to the hip joint, inherited disorders of the hip, or as part of the aging process.
- Lameness is usually mild at first, and slowly gets worse with time.
- Thigh and hip muscles waste, and the hip joint may appear prominent. Occasionally the grating sensation of bone against bone can be heard or felt as the leg is moved.
- The outlook for cases of hip arthritis is very poor as they usually deteriorate with time, and fail to respond to treatment.

Rupture of the cruciate ligament.

- The cruciate ligaments are located in the stifle joint, and run from the thighbone or femur to the shinbone or tibia. Their function is to prevent the thighbone and shin bone from moving forward and backward against one another excessively.
- The ligaments can be ruptured due to twisting of the leg during bulling or service, or to some other accident.
- The lameness which results from a ruptured cruciate ligament is usually sudden in onset. If the animal is closely observed, the leg can click or make a clunking sound when it bears weight.
- If you suspect an animal has ruptured its cruciate ligaments, call your veterinary surgeon to confirm the diagnosis. The veterinarian may be able to detect an increase in fluid in the joint, and this sign assists in confirming the diagnosis.

- The outlook for cases of rupture of the cruciate ligaments is poor as they usually develop stifle arthritis, deteriorate with time, and fail to respond to treatment. In less acute cases, the affected animal can be kept in an area where her movement is minimised, and some may recover sufficiently to be culled.

L. Correct abnormal hoof shape by trimming

The need to trim the feet of cattle at pasture is probably less than the need for foot trimming when cattle are kept in stalls or barns for long periods of the year. In general, the process of walking to and from the milking shed causes wear of the hoof, in most cases eliminating the need for foot trimming. However, some cattle at pasture do develop overgrown claws and trimming may be required.

The aim of trimming is to cut and pare the claws in order to make them function as well as possible. The aim is to return claws to their normal shape and proportions.

Claws that require trimming may include claws that are overgrown or claws that have become misshapen. The process of trimming may involve "shortening" and "levelling" the claws.

Trimming comprises several procedures:

- shorten excessively long walls to achieve a better weight distribution between two adjacent claws,
- remove excessive sole hoof material so that the wall (where it contacts the ground) and the heel of both claws bear most of the weight,
- remove loose horn to avoid pressure,
- prevent penetration of dirt,
- and when associated with abscesses and underrun soles, release discharge and remove underrun areas.

Hoof trimming

The first part of the examination of the foot should involve a careful examination of the claws while the leg is still standing on the ground. The length of the claw, and shape of the claw, should be examined and assessed.

The leg with the hoof to be trimmed is lifted and the foot properly restrained (see Guideline 5).

Once the foot has been lifted, the two claws should be assessed for size and symmetry. The length of the claw is an important starting point. If it is of normal length, it should not be shortened.

The length of the claw

The outer claw is more likely to have abnormal shape and length. The inner claw usually retains its normal shape, but may be too long. Often the inner claw can be used as a guide for the correct shape and length of the outer claw.

The height of the claw

The difference in height between the outer and inner claws can be noted.

After judging length and height, trimming follows a fixed pattern:

For the hind claws

Any excessive length of the wall and toe of the inner claw can be removed with hoof cutters. The hoof knife is then used to pare the bearing surface of the hoof - it should be trimmed so that the sole is flat.

The outer claw can then be cut back to the same length as the inner claw and then pared back to the same height as the inner claw.

The sole of each toe is pared so that it is slightly concave and most of the weight will be born on the outside wall of the hoof.

An angle grinder can be used to remove the dished appearance of slipper feet seen in chronic laminitis, and smooth any rough areas of the outer wall or heel.

The soles of the feet should not be trimmed back too severely - an excessively thin sole may become bruised, and is more readily penetrated by a foreign object.

At the time of hoof trimming, any abnormalities such as white line disease or sole ulcers should be thoroughly investigated.

For the front claws

Regular trimming of front claws is not usually necessary. If front claws to have to be trimmed, the same rules apply as to the hind claws:

- Restore a normal length.
- Trim to equal height

The soles of front feet are normally rather flat hence the slope (concavity) of the sole should be prepared in moderation.

While every effort should be made to restore both claws to the correct length and height, it is important that the hoof trimming not be too aggressive. If underlying soft tissue is exposed, or if the sole of the hoof is pared so that it is excessively thin, an animal that was not lame before trimming may become severely lame after trimming!

In addition, the shape of the underlying soft tissue may be deformed, so that it is not possible to completely return the hoof to its normal shape. In such cases, regular hoof trimming may be required to keep hoof shape as close to normal as possible.

M. Notes on construction of a farm track.

- If constructing a track, plan first!
- Make sure track width is adequate
- Remove grass and topsoil
- Construct drains
- Construct, crown and compact a sound base
- Build a suitable walking surface
- Prevent excess wetness at the yard/track junction
- Maintain tracks
- Track faults increase the risk of lameness!

Cows can walk considerable distances to be milked, and the importance of the farm track as a factor influencing the risk of lameness is well known. Poor quality walking surfaces, restrictions to ideal cow flow, excessive wetness in the environment, and impatient human actions that cause adverse changes to cow walking behaviour are all factors that relate back to the farm track!

In addition, well designed farm tracks can minimise contamination of cows' udders with dirt and mud, reducing the need to wash udders at milking time, and having a beneficial effect on the level of mastitis in the herd.

Farm tracks should be built using sound construction principles. Construction should also allow for planned expansion in herd number. Once built, tracks should be maintained as required. Failure to adhere to sound construction principles leads to excessive maintenance, and failure to maintain increases the risk of lameness and its consequent losses and costs. (See 'What does lameness cost a dairy farmer?' in the introduction.)

Cow numbers will, in part, determine the type and extent of the work needed to build sound farm tracks. The bigger the herd, the greater the amount of work required to construct successful tracks. The farm's management practices will also influence construction. For tracks used rotationally as opposed to daily, a lower construction standard may suffice. Tracks used rotationally appear to recover and reconsolidate, especially after bad weather. There is no relief for farm tracks which are used twice daily.

Applying these principles practically on the farm, and obtaining suitable construction materials locally, and at an acceptable price, can present difficulties.

Planning

- When renovating or building new laneways, it is important to assess their location as part of a whole farm plan. It may be advisable for dairy farmers to talk to agricultural consultants or local advisory officers, and incorporate laneway requirements when planning paddock layout.
- Allow for existing and planned expansion of herd number when considering track width.
- Follow sound construction principles. Consider the types of base and surface materials, what is available locally, and the relative costs of materials. Seek local advice from neighbours and contractors regarding materials and construction.
  Most dairy farmers are constrained by the material that is available locally, and have to identify how best to use the material to give the most effective results. To achieve this, the basic construction principles outlined below should be followed, and local knowledge utilised.
- When designing the track, it is important to avoid right angle bends. Sharp bends slow the pace of cows considerably. Use curves to change laneway direction.
- Also consider other uses the laneway may have.

Track width

- There is little information available on track widths. From research work funded by the Massey University Agricultural Research Foundation, the following guidelines have been established (table below):

Herd size	Track width
<120 cows	5 metres
120 - 250 cows	5.5 metres
250 - 350 cows	6.0 metres
350 - 450 cows	6.5 metres
>450 cows	as required

- If in doubt, farmers may find it worthwhile talking to neighbours, and observing their herds moving under similar conditions.
- Patchett (1994) suggested that the width of the track is dependent on the farmer's individual needs, and the size of the herd. He suggested one metre in width for every twenty cows up to a maximum of eight metres is suitable.

Remove grass and topsoil

- Organic material such as grass and manure should be removed first.

Drainage:

Effective drainage is an essential component of good track design and maintenance. The importance of correct drainage must not be underestimated!

- Drains are required along either side of the track to prevent water seeping into the base from the surrounding ground. It is not sufficient to dig the drains, then let them fill with water. They must be correctly graded, and the water must have somewhere to flow to, if the drains are to function correctly.
- In some cases, material from the side drain construction can be used to build the track base above ground level.
- The drains should be fenced off from the track so that cattle cannot walk in them, and cause damage. Electric fence wire on outriggers from the paddock electric fence will leave access for a tractor blade during surface maintenance.
- Culverts will be required where there are paddock entrances across side drains or where water needs to be drained under the laneway. Smaller diameter culverts are often a false economy, 300 mm diameter culverts are suggested for most situations.
- Wherever possible, the water table should be kept at least 600 mm below the track surface. The higher the track above the water table, the better.

Construct, crown and compact a sound base

If the foundation is not adequate, laneways will break down and need to be rebuilt. The base should support the wearing course or walking surface without moving, wetting or breaking up. This can be achieved by using a suitable base course material, and if necessary, stabilising and strengthening the existing material and/or placing down a filter fabric as outlined below.

- Adequate compaction of the track base is very importance. Options include the use of a power grader with an experienced driver, a tractor with a mounted blade, a pneumatic tyred roller, or a loaded vehicle with high pressure tyres. In many cases a vibrating roller will produce the best results. The base should be built up in layers not exceeding 150 mm in depth, and each layer should be thoroughly compacted.
- The top of the track base should lie above the water table, and be free from pugging. In many cases, additional material may need to be bought in to make sure that the track base is sufficiently high to allow good drainage.
- If the quality of the foundation material is not acceptable, it will be necessary to bring in suitable material such as pit or river run gravels to form a base. These need to be compacted firmly into

place.
Soft clay must not be used to form the base of the track. It will not compact to a stable nature. Clay surfaces can be stabilised by mixing hydrated lime to a depth of 125 mm. Cement can also be used for stabilisation - application rates of 1 to 4 % are usually recommended. Other forms of stabilisation include enzymes (Paczyme) and ionic soil stabilisers (eg Terra Firma).

- Problems with boggy sections or wet areas around gateways can be overcome by using a plastic fabric laid on the base material. This fabric allows the downward movement of water, but retains the gravel particles on top, keeping them where they need to be. The fabric must be laid above the water table.
- Tracks are "crowned" to help shed water and maintain a relatively smooth wearing surface. The slope across the track should be sufficient to shed water and be comfortable for the cows. A slope of about 10 percent should achieve this. In some situations the base can slope to one side to suit the lie of the land.

Construct , crown and compact a walking surface

The surface (or the wearing course) serves two functions:

1. It provides a suitable surface for the cows to walk on. The materials used should be able to compact into a hard, smooth, wear-resistant top that water will run off, not seep through. The material should consist of well-rounded granular particles which will not cause hoof damage. It should not have sharp stones which can cut the hooves, and should be free of loose stones which can cause bruising.
2. It must prevent seepage of water through into the base.

To achieve these two functions, the surface must be bound together in some way by using:

1. 1.top course gravels,
2. 2.stabilisation,
3. 3.green lime,
4. 4.rotten rock,
5. 5.or river sand or silt.

- If top course is used, it should consist of well rounded gravels less than 25 mm in diameter, and have a 15-30% clay content. A minimum depth of 50 mm of surfacing material should be used, with 100 mm being more suitable. It should be crowned and extremely well compacted. The success or failure of this type surfacing is dependent on the compaction.
One suggestion is that the ideal surface material is a mixture of gravel, sand and clay, approximately 100 to 150 mm in thickness. The finer particles will fill the pores between the larger particles, binding the material and forming a hard wearing and relatively smooth surface. Large stones should be avoided as these get kicked out of the track and leave a site susceptible to water and damage.
- Green (agricultural) lime is another alternative as a surfacing material. Care must be taken to check that local lime is suitable for this use. Some green limes cannot be compacted into a tight wear- and weather-resistant surface. If suitable, a layer of lime 50-100 mm thick is spread and mixed in with the top 25-50 mm of base. It needs to be crowned and compacted firmly into place.
- Sand should never be used on its own as a surface material because it is very abrasive. It is carried from the track into the concrete yards. There it quickly wears down cow's hooves as they walk or mill around on the concrete.
- It is essential that the materials are adequately compacted. The use of a vibrating roller during the course of track construction can greatly assist in making sure that both the bearing surface and foundations are well compacted. Cows cannot be used to do this!
- The slope (camber) across the track should be sufficient to shed water and be comfortable for the cows. A slope of about 1 in 10 should achieve this.
- Often, many farmers do not have many choices with respect to the type of materials they can use in construction of farm tracks due to cost constraints. However, this limitation can be overcome

provided proper attention is paid to construction, particularly with respect to adequate compaction and drainage.

The yard/track junction

- The junction of the concrete yard and the farm track has the potential to cause problems because:
- Wash-water or rainwater from the concrete yard runs onto the track causing a wet area where the track surface may break down.
- Cows often manure on the track before walking into the yard, particularly if there is a problem in the yard or shed.
- Cows may carry sand, gravel and small stones from the track onto the concrete surface of the yard. These may damage the feet of cows in the yard.
- It is important to prevent water from running off the concrete yard onto farm laneways. To avoid this problem, slope the concrete down from the junction, or form a curbing on the edge of the concrete to control drainage.
- Cows should be encouraged to move away from the shed after milking. Otherwise, accumulated manure will form a barrier to drainage along the edge of the laneway near the shed, ultimately causing breakdown of the laneway.
- Similarly, laneways close to the shed should not be used as a holding facility if the cowshed yards are not large enough to hold the required number of cows.

Management of farm tracks

- Holding stock on tracks: If tracks are used to hold stock during wet weather, or hold stock until all the cows have been milked (so that the entire herd can be placed in the new break of grass at the same time), the track can deteriorate quickly. This can result in the breakdown of the track walking surface, and exposure of the underlying track base. Such damaged areas of farm track increase the risk of lameness, and place pressure on the drainage system. This practice is strongly discouraged.
- Vehicle access: Farm tracks are for vehicles as well as stock. Tractors in particular lift and rut the surface very quickly. Although it is usually not practical to provide a separate access system, damage can be minimised by using suitable vehicles (e.g. four-wheeler bikes) and keeping speeds down.
- Fencing: It has been normal practice to fence along the outside edge of the drain. However cows tend to walk on the softer base in the drain, slowly destroying it. This leaves the cows muddy, and the drain fails to function properly.
  One recommendation has been to fence the track so that the drain is on the other side of the fence. However material may still build up at the edge of the track, and prevent water entering the drain. An alternative approach may be to run a couple of electric wires along the edge of the track suspended from the fence posts along the drain. This permits the drain to be cleaned easily, and allows any build up of sludge at the edge to be readily removed.
- Continued maintenance : Repair of farm tracks can effectively prolong their useful life. Potholes and impressions should be filled and compacted as they occur. A tractor blade is useful for maintaining a crown, and reforming any broken edges. Drains must be kept clean to prevent blockages and water undermining the lane.

Track faults that increase the risk of lameness:

- Poor quality walking surfaces: Once the surface layer of the farm track breaks down, water flows into the track rather than off it, and the base material of the track is exposed. Cows then walk on unsuitable material and foot damage can occur. For example, stones may bruise the soles of cow's feet, and if sharp, cut them.
- Poor track drainage : Many farm tracks have unsatisfactory drainage. In the basic design of farm tracks, adequate drainage is often not given sufficient consideration. If drains are not fenced off, cattle walk in them, and spread track material and manure into the drain â€“ destroying their ability to remove water effectively. If drains are fenced off, grass and manure can build up along the edge of the track, preventing drainage off the track. The net result is that the track remains wet for longer

than necessary, the walking surface becomes damaged, the course track base material is exposed, and foot damage can result.

- Avoidable wetting of the farm track : Leaking troughs, irrigation delvers and irrigation run-off can subject the track to unnecessary and excessive moisture and wetness. Trees and hedges near the track prevent sunlight and wind from drying shaded areas. Track damage can result.
- Track width: Many farm tracks are too narrow, resulting in poor cow flow. This may not cause a lameness problem if the herdsperson bringing the herd to the shed is patient. However in many cases, slower cow movement results in the herdsperson attempting to hurry the rear cows. Adverse changes to cow walking behaviour occur, and the risk of lameness increases. On a wide section of track, a herd will flow at up to 4.5 km/hour, but often as slow as 1.5 km per hour on a narrow track.

N. The correct use of footbaths.

- Effective for prevention of bacterial infections that cause lameness such as footrot and hairy heelwarts
- Have a limited ability to harden the hoof horn
- Largely ineffective in preventing lameness caused by poor quality walking surfaces
- Must be used regularly to be effective

Regular footbathing using formalin or copper sulfate has been widely recommended to control and prevent lameness in dairy herds. Although footbathing has been found to be effective in treating and preventing lameness caused by bacterial infections such as footrot, there is little evidence that it is effective in preventing lameness caused by injury to the hooves, resulting in conditions such as bruised soles or puncture of the sole.

The use of footbaths for prevention of bacterial causes of lameness

- In outbreaks of lameness caused by bacterial infection of the skin between the claws or above the hooves, such as footrot, the regular use of footbaths can provide effective treatment and prevention. The objective is to remove erosive materials from the foot and to disinfect the skin above the hooves. Solutions of 5% formalin or 5% copper sulfate are usually used. In some instances, for the treatment of hairy heelwart, antibiotic solutions are recommended. Formalin is irritant and a dangerous chemical to use. Repeated applications can cause skin burns to the legs and udders. Seek veterinary advice as to the best chemical to use.

Footbathing for prevention of traumatic hoof injury

- Footbathing with formalin or copper sulfate has the effect of drawing moisture from the hoof and hardening it. The intention of this treatment is to make the hoof more resistant to injury from stones and rough walking surfaces. However research trials have not demonstrated any reduction in lameness caused by conditions such as white line disease or sole bruising.
- Some reasons why footbaths are not effective are:
- Formalin and copper sulfate penetrate the hoof poorly, so only harden the surface layers of hoof. Dairy cows walking on gravel roads and concrete yards quickly wear these hardened superficial horn layers away. To be effective, footbaths have to be used regularly, probably daily.
- Footbaths quickly become filled with manure and slurry as they are usually placed on the exits of the dairy. This dilutes the concentration of chemical in the footbath, and renders the footbath useless. To maintain concentration, footbaths need to be recharged after the passage of about 100 cows. Where footbath solutions are not replaced for several days in large herds, they have little chance of providing effective treatment for the majority of animals.
- Where more concentrated solutions are used, and more frequent application is adopted to harden the hoof horn, splashing of chemical can result in skin burns to the lower legs and udder. Footbathing can then cause lameness rather than prevent it.
- Footbaths are usually placed in the exit races of dairies. This can have the effect of restricting cow flow from the dairy, resulting in unnecessary jostling of cows and rough handling by the operator factors known to increase rather than decrease the risk of lameness.
- The need to harden hooves is greatest in wet weather as hoof material softens with increasing moisture. Under wet conditions, as soon as cows leave the exit race and footbath, they usually walk into muddy and wet areas and the applied chemical is quickly washed off the foot.

Construction of a footbath

- Footbaths need to be situated in a race wide enough for the passage of cows in single file, and be approximately 2.5 meters in length to ensure all feet pass through the bath. Do not overfill the footbath the chemical in most instances should only cover the hoof. Excessively deep baths or concentrated chemicals can result in burns when splashed on the fetlocks, teats or udder.

Recommended footbath solutions

- Solutions of 5% formalin or 5% copper sulfate are the most commonly used chemicals in footbaths. Formalin, in particular, is irritant and dangerous to use. Operators must take great care when pouring formalin concentrate into the footbath. Avoid direct contact with the skin or eyes.

Hoofmats are an alternative to footbaths

- Hoofmats are mats designed to be charged with a footbath chemical such as copper sulfate which is squeezed out around the cow's hooves as she walks on the mat. They can provide an alternative to the use of a footbath. The mats can be placed on the entrance to the dairy rather than the exit. This allows the treatment to soak into the hoof for the duration of milking before the cow walks into dirty and wet conditions again. When regularly recharged and used often (every milking), they can be effective for hardening hooves and perhaps increasing resistance to lameness.

O. How to apply and remove a glue-on plastic shoe

- reduce pain
- minimise the severity lameness
- protect the injured claw
- hasten return to full production

A number of diseases of the claw "especially sole abscess and sole ulcer " result in loss of the protective layer of sole hoof, exposing the very sensitive and raw underlying soft tissue (the corium).

In the case of sole abscess, the underrun sole may not be exposed until it is treated, or until it lifts away as a flap. In the case of a sole ulcer, or when only a proportion of the sole is underrun, the remaining sole can act as a trap for stones and gravel, further adding to hoof disorders.

Exposure of the corium is important because walking on it causes severe pain and lameness, and secondly, because the protective layer of sole is absent, it is vulnerable to further injury from stones and gravel.

A plastic shoe offers protection for the exposed corium because when correctly applied to the sound claw of the same foot, it lifts the affected claw off the ground, both reducing pressure on the raw surface and lifting it above potentially harmful stones and gravel.

Properly fitted, a plastic shoe reduces the pain of lameness, assists in return of the cow to full performance, and protects the sole from further injury.

Check the sound claw with hoof testers.

The cow will be bearing all the weight of the lame leg on the claw to which the plastic shoe has been applied. If the plastic shoe is applied to a painful claw, the lameness may become more severe.

It is essential to check the hoof to which the plastic shoe is to be applied is sound and able to bear the cow's weight. After cleaning its sole, and checking for hoof defects, check it with hoof testers to make sure that it is sound and pain free.

Prior to fitting a plastic shoe, clean and dry the sound claw thoroughly.

The adhesive relies on a clean, dry and roughened sole and hoof wall surface for maximum bonding to the hoof material. Use a hoof knife to remove excess dirt and manure from the sole, wall and interdigital areas. If necessary, use water and a scrubbing brush for cleaning, then dry with a cloth or paper towel. Scrape the sole and wall with the hoof knife, notching" the surface of the sole to act as a key for better adhesion. Pour methylated spirits over the sole surface and allow this to dry. Alternatively use a 4" angle grinder with a paper disc to clean both the sole and hoof wall. The disc edge can be used lightly to create notching in both the sole and the wall.

When properly prepared, the hoof should be spotless and dry. If it is raining, shelter may be required to achieve a dry sole. Do not use power tools in the rain!

Make sure the plastic shoe fits the sound claw.

Large cows (and bulls) may need the hoof wall sanded so that the plastic shoe fits the hoof. Animals with a long claw may also need hoof trimming of the point of the claw for a good fit. In small animals, the inner wall of the plastic shoe may need to be trimmed so that the plastic does not rub on the skin of the interdigital space.

Mix the powder and solvent and apply the plastic shoe to the sound claw.

Gloves should always be worn when handling the powder and solvent as it may be irritant and some people develop a severe allergy to this material.

The plastic shoe is used as a mixing cup for the solvent and powder. Pour the liquid solvent into the plastic shoe, then add powder slowly. Use the supplied wooden stick to make sure that a good mix is prepared. In cool conditions, it is often useful to warm the mix before applying the plastic shoe to the foot " this reduces the setting time. Make sure no dry powder remains within the plastic shoe. Make sure adhesive is spread thickly over the inner sole of the plastic shoe, and smear adhesive over the walls.

Apply the plastic shoe to the sound claw, and press it on firmly. Scoop excess adhesive away with the stick. Make sure no adhesive bulges into the interdigital space where it may irritate the affected claw. Allow sufficient time for the adhesive to cure and harden.

If necessary, remove the plastic shoe when healing is complete.

Most plastic shoes fall off after three to four weeks of use. Occasionally they stay on too long, and irritate the affected claw. Hoof cutters can be used to cut the wall of the plastic shoe, and prise off the device. Also the edge of a 4" angle grinder disc can be used to cut the wall of the plastic shoe. Alternatively a screwdriver can be inserted down the front of the hoof, between the wall and the plastic shoe, to lever the shoe away.