

Footrot Manual for Contractors



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11/11/14

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INTRODUCTION

Footrot is a highly contagious disease caused by bacteria that infect the feet of sheep.

The disease causes severe pain and lameness in affected sheep and has an enormous impact on flock productivity and profitability by reducing wool production, causing poor growth rates, lowering ewe fertility and restricting the sale options of infected sheep.

The cost, labour and other resources involved in controlling footrot can cause financial, physical and mental stress.

Many of these costs are avoidable. Footrot can be eradicated and controlled in a cost-effective manner.

The serious nature of footrot has resulted in many State governments enacting legislation to control footrot but many have no legislative control.

Prompt, expert advice about footrot control is essential to minimise the cost of footrot.

Successfully dealing with footrot requires commitment, understanding and open dialogue between farmers, contractors and their advisers.

Footrot contractors are seen by many to be an essential part of footrot eradication. It has been demonstrated that producers who use contractors spend significantly less time under quarantine than those who attempt eradication on their own.

This manual gives an overview of footrot and covers the key elements of establishing a successful program to eradicate the disease.

This manual gives an overview of footrot and provides a pathway for the development of a footrot program which successfully eradicates the disease. The workshop has been aligned to the following unit of competency from AHC30110 Certificate III in Agriculture:

AHCLSK309A Implement animal health programs.

What is footrot?

Footrot: The bacteria

Footrot is an infectious disease of sheep, cattle and goats. It occurs throughout Australia but is most prevalent in the medium to high rainfall areas.

Footrot is caused by a bacteria called *Dichelobacter nodosus* (previously called *Bacteroides nodosus*), which thrives in moist, warm conditions. For the bacteria to become established in sheep feet there must be a break in the interdigital skin which usually occurs in wet conditions resulting in maceration in conjunction with bacteria such as *Fusobacterium necrophorum*.

The footrot bacteria needs the feet of infected animals to survive. The bacteria can survive indefinitely in pockets of infection inside the feet of infected animals, even under dry conditions. **The bacteria cannot survive for more than 7 days in soil.**

There are many strains of the footrot bacteria which vary in their ability to cause disease.

Some strains never cause serious footrot in sheep, regardless of the environmental conditions. These are called **BENIGN STRAINS**.

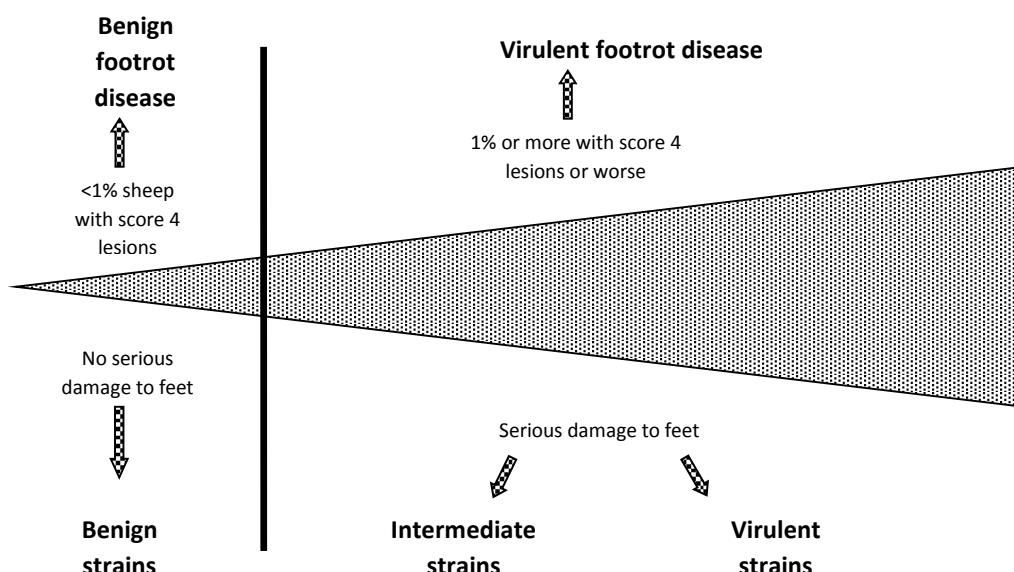
Other strains cause severe footrot lesions and spread rapidly in warm, moist environmental conditions. These are called **VIRULENT STRAINS**.

In between these two extremes, there is a complete range of strains based on their ability to cause footrot (Figure 1). All these bacteria look identical under the microscope.

A good understanding of footrot is essential to control and eradicate the disease.

The basic principles to be aware of are:

- **Footrot gets onto farms on the feet of infected sheep, goats or occasionally cattle.** The disease can come from straying livestock, a recently purchased prize ram or from that bargain mob of wethers snapped up at the last sale.
- **Boots, tyres and wildlife** are of minimal importance in spreading of footrot.
- **Farms are not infected with footrot, the animals on the farms are.**
- **A paddock which has had no sheep, goats or cattle in it for seven days can be guaranteed free from footrot.** Clean (uninfected) sheep can be put in such a paddock with absolute confidence that they will not contract footrot.
- **Footrot bacteria can be found on healthy feet or in pockets left in partially healed feet.** Don't assume your new sheep are free from footrot just because their feet look healthy. They may be carrying a highly virulent strain of footrot but conditions have not favoured development. Alternatively they may be carrying a benign strain that shows no signs of disease at that time.



Footrot: The disease

The severity of footrot depends on three factors:

1. **Strain of footrot bacteria:** Benign strains can never cause severe disease. In contrast, highly virulent strains will cause severe disease when the environment favours their spread and development in feet.
2. **Sheep factors:** Some breeds of sheep are more resistant to footrot than others. For example, British breed sheep less predisposed to having badly affected feet even when infected with virulent strains of footrot. In contrast, Merinos tend to be badly affected when infected with virulent strains. Within the one breed of sheep, some sheep are more resistant to footrot than others.
3. **Environmental factors:** Moisture and temperature are important factors affecting the transmission and expression of footrot. Research shows that footrot only spreads between sheep when the mean daily temperature is above 10°C. If temperatures are too low in winter footrot will not spread between sheep, even though moisture is not limiting. Footrot will not spread under hot, dry conditions. For outbreaks to occur in winter and spring >50 mm/month of rainfall was required, although in cooler periods footrot spread will occur in months with less rainfall, especially where pastures are lush. In summer 125 mm/month was required and 60 mm/month in autumn. This is why the main footrot spread period is during spring, wet autumns and mild winters. Note that in cold conditions, individual lesions can still progress on infected sheep and even in dry conditions individual lesions can progress, though many will start to resolve once conditions are dry.

Where on the foot do I find footrot and what does it look like?

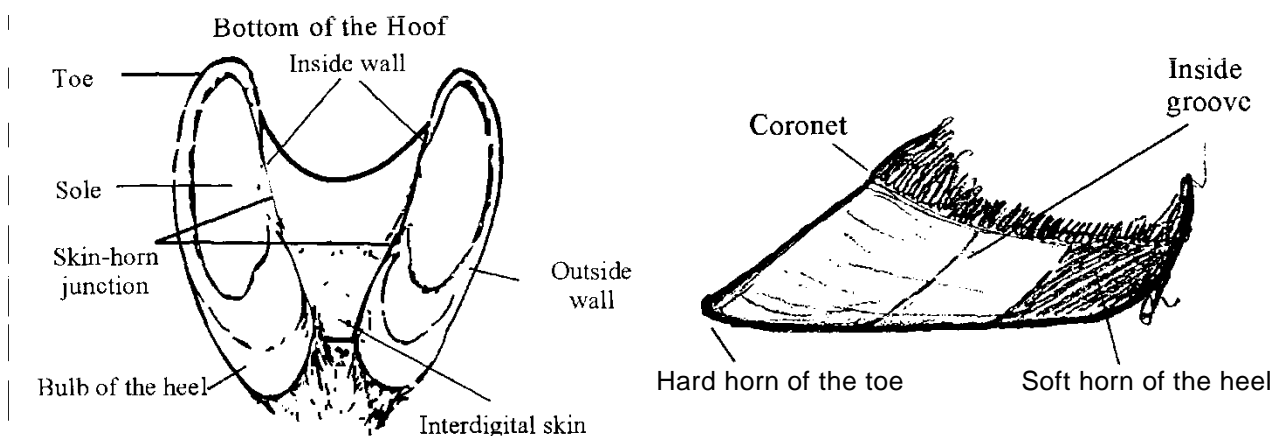
Before you can look for footrot, you must know the structure of a sheep's healthy foot and where to look for the changes that occur with footrot.

Sheep's feet are often full of muck. To get a good look at the areas of interest this muck will have to be cleaned out. The areas of the hoof to look at are shown in Figure 1.

- **The interdigital skin (webbing):** Look for hair loss and reddening of the skin.
- **The inside skin of the toes and the soft horn of the heel:** Look for reddening, erosion of the skin and white (dead) tissue.
- **The skin/horn junction:** Look for separation of the horny layer from the skin.
- **The sole of the heel:** Look for progressive separation. As the disease progresses the separation moves to the outside edge of the sole and then extends forward.

The characteristic signs of footrot, in progressive order are inflamed, red moist skin between the toes, with a smelly grey, paste-like scum between the toes. Separation (or under-running) of the horn from the soft underlying structures usually starts at the skin horn junction of the heel. The expression of the disease depends on the environment, the time of year, the type of sheep and the strain of the footrot bacteria.

FIGURE 1 THE STRUCTURE OF THE SHEEP'S FOOT



The stages of footrot

A four -stage scoring system has been developed to describe the progression of the disease with Score 1 being the earliest stage of infection and Score 4 being the most advanced stage of footrot. (Note some record a severe score 4 lesion as a score 5)

The first sign of infection is on the skin between the toes, in the interdigital skin. This skin becomes red and hair on the skin falls out. There is no separation of the horn from the foot (Score 1 & 2).

Given warm, moist conditions, the disease can rapidly develop into Score 3 or 4 footrot if a virulent strain is involved. Score 3 footrot involves separation of the horn starting at the inside edge of the heel at the skin horn junction (score 3a) and continuing at least half way across the heel (score 3b). A grey, paste-like scum will form between the separating horn from the soft tissues of the feet and often has a distinctive, foul smell.

If only mild strains are involved, then this will be as far as the disease progresses, regardless of the environmental conditions. However, with more virulent strains the disease is just starting to develop.

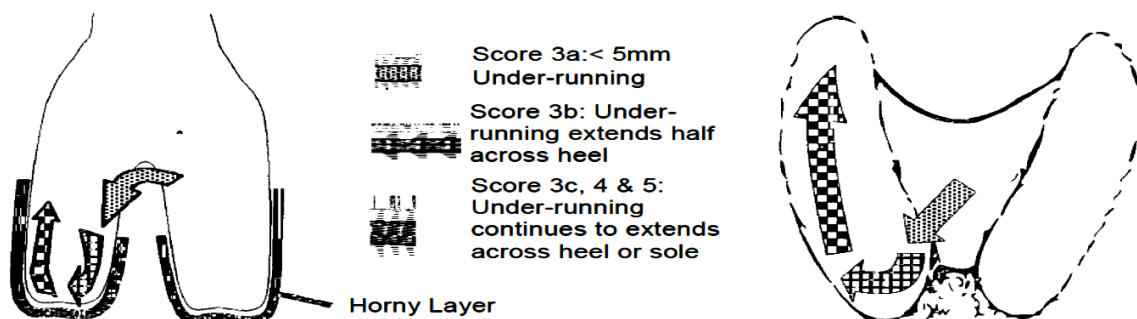
With more aggressive strains, in a wet, warm environment, the separation of the horn progresses across the heel to the outside wall of the hoof (Score 3c). This is a characteristic sign of more aggressive strains of footrot. No other disease causes this sign.

In very badly affected sheep, the whole of the horny layer of the hoof can be separated from the foot (Score 4). This causes extreme animal welfare problems in the affected sheep. Sheep with both front feet affected will often kneel to graze because of the severe pain associated with standing. Figure 2 indicates the progression of

footrot disease (and relative lesion scores) through the hoof.

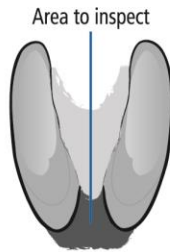
During summer, when the conditions are warm and dry, the hooves will harden and many lesions will self cure. On some feet, horn may grow over the footrot lesion, allowing the bacteria to survive in pockets in the sheep's feet. Animals carrying pockets of footrot infection through the summer often have misshapen feet. The bacteria is carried in pockets in the feet and can survive for many months. When wet, warm environmental conditions allow better survival of the bacteria in the environment. and wet conditions enable maceration of the interdigital skin, the bacteria will spread between sheep and trigger another outbreak of footrot.

FIGURE 2 PROGRESSION OF FOOTROT THROUGH THE HOOF



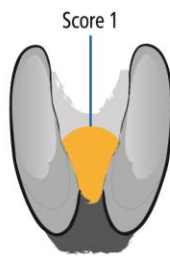
Footrot Scoring

Normal Foot



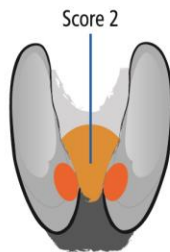
Score 1:

Limited mild interdigital dermatitis; slight to moderate inflammation confined to the interdigital skin and involves erosion of the surface layer of the skin. The skin between the toes is inflamed, red, moist and shedding hair.



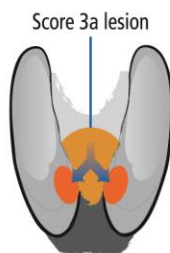
Score 2:

More extensive interdigital dermatitis; severe inflammation of the interdigital skin which involves part or all of the soft horn of the inside wall of the toe.

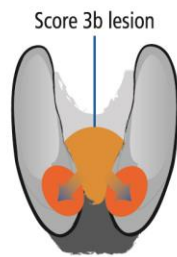


Score 3a:

Separation at the skin horn junction, with under-running extending no more than 5 mm.

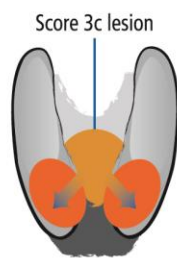


Images courtesy of Coopers Animal Health



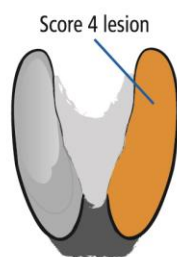
Score 3b:

Separation of the horn extends up to halfway across the heel or sole.



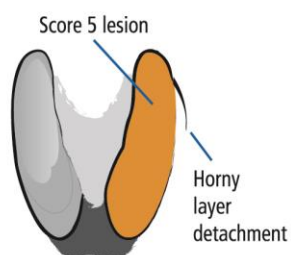
Score 3c:

More extensive separation of the heel or sole but not extending to the outside edge of the sole of the foot.



Score 4:

As for Score 3 but with the separation extending to the walls and outside edge of the sole of the foot.



Score 5:

Necrotising inflammation of the deeper tissue of the outside wall with consequent separation of hard horn of the foot.

WHAT HAPPENS IN A FLOCK

Not all sheep in a flock will be affected by footrot. Even if the footrot is caused by a highly virulent strain of disease, some sheep in the flock will look normal.

The pattern of disease within a flock is mainly determined by the environmental conditions (climate and pasture) and the strain of the footrot bacteria involved. With a prolonged spread period lower grade strains may have the ability to progress to more advanced lesions. Likewise in dry conditions, the expression of disease may look less. Footrot control measures such as footbathing may reduce the expression of disease too. All these factors must be considered when making a diagnosis which in some circumstance may take over a year to be confident of the diagnosis, especially if seasonal conditions are dry.

Benign strains of footrot:

A flock infected with a benign strain will show few signs of footrot most of the year. In dry years there may be no sign of the infection.

The disease is usually most noticeable during spring when some of the sheep may appear lame and have Score 2 & 3a lesion. More than 20% of a mob may be affected with Score 1 & 2 feet but less than 1% may progress to Score 4.

As the weather becomes warmer and drier, affected feet will 'self-cure' and there may be no visible sign of infection. This makes it tempting to think the disease has gone but the footrot bacteria will still be in the feet of many of the sheep.

The disease will reappear with the next spell of warm wet weather, for example, in the following spring, and cause more lameness.

Virulent strains of footrot:

A flock infected with a virulent strain may show no signs of footrot until suitable weather causes sudden severe lameness in large numbers of sheep.

This usually happens at the start of spring and within a matter of weeks, an inspection of the flock will show many are suffering from the horn separating from the foot.

If no control measures are taken, many of the feet will progress to Score 4. Even if no treatment

is given, some of these sheep will 'self-cure' over summer.

Other sheep in the flock will have chronically and badly affected feet (Score 4) that may become flyblown. Culling these sheep alone during summer will not eradicate the disease.

The footrot bacteria will still be in the feet of many sheep, waiting for the next bout of wet, warm weather to multiply and cause the next disease outbreak.

Intermediate strains may look like virulent footrot in some sheep but this is generally in only a smaller percentage of which many self-cure in summer.

Table 1: The Footrot Complex

	Benign	Intermediate	Virulent
Severity of disease	mild	moderate	Severe
Ability to heal when dry	high	moderate	Low
Lesions	Mainly score 1-3a	Score 2-4	More Score 3-4
Protease thermostability*	-ve	-/+ve	+ve
Elastase*	-ve	Low positive	positive
IntA PCR^	+/-	+/-	+/-
% sheep score 4	<1%	1-3%	>3%
% lesions >3c*	<10% score 3		>20% score 3c/4

* usually negative for benign strains and positive for virulent strains but many strains less virulent but are clinically benign vice versa

^ IntA least reliable of tests

It is important to note that laboratory tests are only a guide and should not be relied upon for a final diagnosis. Legal requirements vary between states though for Victoria at least the diagnosis should be based on clinical expression. Difficulties arise when laboratory tests indicate virulent disease and the strain is clearly benign based on clinical expression.

Table 2 Typical distribution of lesions with Virulent, Intermediate (low grade virulent) and Benign Footrot under ideal environmental conditions. (from Raadsma & Egerton 2013)

Clinical form Score	VFR	IFR	BFR
Score 4	10-70+	1-10	0-1
Score 3	10-50	10-30	1-15
Score 2	5-50	20-70	10-80+
Score 1	5-10	5-10	5-10
Score 0	30-50	30-60	20-80

HAVE MY SHEEP GOT FOOTROT?

Different strains of the footrot bacteria can cause footrot disease (Table 1).

Some of these strains are so mild that they do not cause an economically significant form of the disease. It is technically impossible to eradicate some of the milder strains of footrot. In many cases, eradicating mild strains of footrot doesn't warrant the cost involved.

On the other hand, the severe strains (many intermediate and virulent strains of footrot inevitably result in economic losses and welfare implications if not controlled. There are major benefits in eradicating these strains from affected flocks.

To assist in managing footrot, the disease is split into two groups - mild (benign) footrot which is economically insignificant and severe (virulent) footrot which needs to be eradicated. Generally most intermediate strains of footrot should be eradicated.

- **Virulent Footrot:** This is the severe form of footrot. If a diagnosis of Virulent Footrot is made, the farmer is obliged to eradicate the disease. This makes sense. We know these forms of footrot can be eradicated and it is cost effective to do so.
- **Benign Footrot:** This is the less severe form of the disease. If a diagnosis of Benign Footrot has been made, the farmer is not obliged to eradicate the disease, it is not cost effective to eradicate and probably cannot be eradicated.

These sheep are lame, have they got footrot?

Lameness is often the first sign of footrot. There are several other conditions which cause lameness which means it is essential to make a proper diagnosis. An incorrect diagnosis may lead to substantial economic losses due to inappropriate management.

Diagnosing lameness determines which of the following conditions is affecting the flock:

1. **Virulent Footrot**
2. **Benign Footrot**
3. **Other conditions**

Differentiating between the different causes of lameness can be difficult and expert help should be sought to diagnose the cause of the problem.

It is important to consider the history of the sheep as both environmental conditions, sheep breed and previous treatment such as footbathing will affect the clinical expression of the disease.

Field diagnosis of lameness requires a large number of sheep to be carefully examined and foot scored. It is not good enough to just tip over a couple of sheep to make a diagnosis.

Initially, it is safest to examine sheep in the paddock instead of moving them to the yards. This will avoid possible cross infection of other mobs that use the same lanes or sheep yards. To inspect large numbers for a diagnosis, yarding and close inspection is necessary.

When lameness is first observed at least 20-100 sheep should be examined. All four feet must be examined for any abnormalities.

If separation of the horn from the foot is observed (footrot lesions Score 3b & above), then virulent footrot must be considered and expert advice must be sought.

Sometimes sheep can be identified and foot-scored and re-examined 2-3 weeks later. Progression from score 2/3a to score 4 in this period is indicative of virulent footrot

If no signs of footrot are observed another 100 sheep must be examined. If no footrot lesions are found on these sheep (assuming conditions have been suitable for the expression of footrot) then another cause of lameness should be diagnosed and suitable treatment given.

If any sheep have the horn separating from the foot you can be sure you have either Virulent or Benign Footrot.

The main feature that distinguishes virulent footrot from benign footrot is the proportion of sheep in the mob that have feet with horn separating from the sole of the foot (Figure 3).

A clear diagnosis of virulent footrot can be made if 1% or more of the sheep are affected with Score 4 feet. Promptly seek expert advice. Check state regulations of your responsibilities to reporting and management of virulent footrot. Note that there may be small variations on the definition of virulent footrot between states.

A diagnosis of benign footrot can be made if the proportion of sheep with the horn separating from the foot is less than 1% of sheep (following a normal spring & without treatment). Seek expert advice on diagnosis and control.

Check state regulations on the control of footrot and the sale of sheep.

Other conditions that may be confused with footrot are:

Heel Abscess:

- Usually caused by *Fusobacterium necrophorum*, a bacterium endemic in the environment
- Usually only a small percentage of the mob is affected, but can affect large numbers, especially when wet and muddy or occasionally with grass seed impaction
- Usually only one foot affected
- Hoof is hot and abscess site swollen
- White or creamy pus breaks out of the abscess, usually at the coronet
- No characteristic smelly footrot odour
- No separation of the sole, except where an abscess may break open
- Primarily seen in heavy sheep, especially late pregnant ewes and rams

Toe Abscess:

- Caused by *Fusobacterium necrophorum*
- Very painful, Foot is hot and sheep hold foot off the ground
- Often red polyp of proud flesh on toe
- Low numbers of sheep affected
- Often associated with overzealous foot paring

OID (Ovine Interdigital Dermatitis):

- Similar to Footrot Score 1 lesions
Affected skin is covered with moist grey scum occurs between heels where skin rubs
- No under-running of soles
- Can lead to foot abscess or footrot if the bacteria present

Shelly Toe:

- Outer layers of horn separate on the outside of the toe
- Cavities in the hoof are packed with dirt and faeces
- Usually associated with wet muddy conditions
- Sheep are not usually lame
- Can lead to toe abscess

Strawberry footrot:

- On the back of the foot or up the leg
- Caused by same organism as "DERMO"
- Scabs on the skin at the back of the coronet
- Raw spongy tissue with "strawberry appearance" may be revealed when scabs are removed
- Hoof can be hot and swollen
- Primarily affects weaners and hoggets

Scabby Mouth:

- Affects the feet both above coronet and in the interdigital space where scabs form
- Often in young sheep grazing lush pasture or occasionally rough pasture/stubble although the oral form of the disease is more common in dry conditions
- Raw spongy tissue is revealed when scabs are removed
- No involvement of horny layers
- Some sheep in the mob will have mouth lesions

Laminitis:

- History of introduction of grain or grain engorgement
- Sheep appear tender footed
- Reluctant to walk
- Hoof can separate from foot in severe cases
- Usually all feet affected

Grass Seed Impaction:

- May be swelling at site
- can cause abscess with pus draining from sinus
- Impaction most common in interdigital area

Cathead Burr (*Tribulus terrestris*):

- Thorns puncture sole
- Small abscess under sole with pus
- No erosion of skin horn junction

Each of these disease have different control and prevention strategies. Differentiating between them can be difficult seek expert advice.

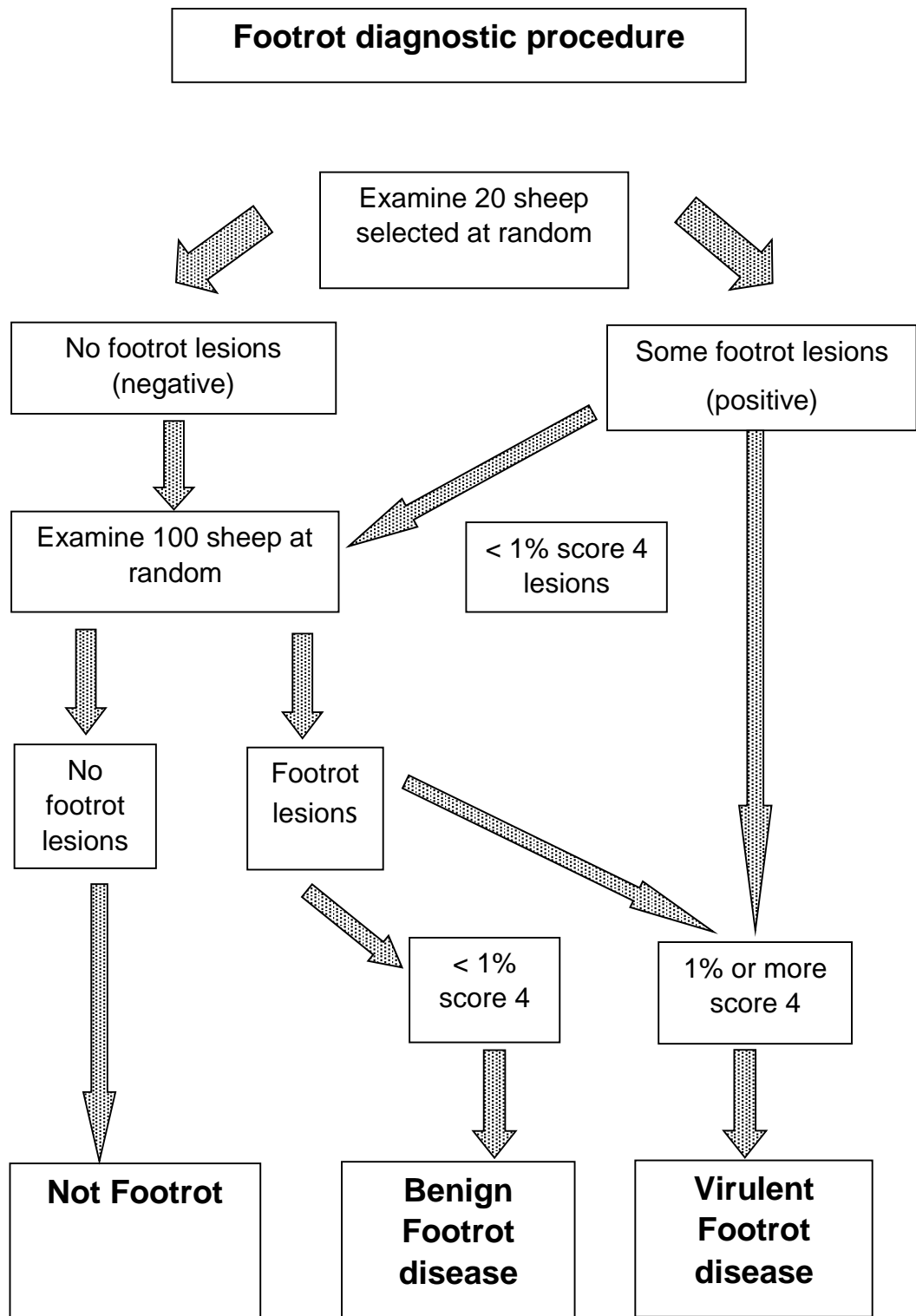


FIGURE 3 FLOWCHART FOR DIAGNOSING FOOTROT

WHAT ACTION IS TAKEN IF MY SHEEP GET FOOTROT?

The course of action that needs to be taken depends on whether the sheep are suffering from Virulent Footrot or Benign Footrot.

In some circumstances an accurate diagnosis of either of these conditions may take up to a year with the help of expert advice.

Footrot diagnosis is not a 'Do-It-Yourself' job - in all cases seek expert advice.

How Do I Deal with Benign Footrot?

Farmers with sheep with benign footrot can either decide to control the disease, or do nothing.

The following issues must be considered when dealing with Benign Footrot:

1. Many forms of benign footrot cannot be eradicated.
2. Sheep with any footrot lesions must not be presented for sale in a saleyard.
3. Differentiation between benign and early virulent footrot in saleyards is not usually possible.

The choice depends on the personal preferences and circumstances of the farmer. It is best to decide only after consultation with an adviser (Figure 4).

When no action is taken to control benign footrot, the farmer should regularly monitor the flock to ensure control strategies can be adopted if necessary, depending on prevailing seasonal conditions.

Controlling Benign Footrot depends on seasonal conditions, involves footbathing and continual assessment.

Eradicating Benign Footrot depends on reasons other than the production losses associated with the disease.

Farmers may choose to attempt eradication of benign footrot because they:

- Sell store sheep
- Have a stud or ram selling enterprise
- Are driven by their social conscience and want to minimize the risk of footrot spreading in the community.
- only consider with a borderline intermediate strains

Attempting eradication of benign footrot involves the same methods as eradicating virulent footrot but the chances of success are low and in many circumstances will not be possible so should not be attempted.

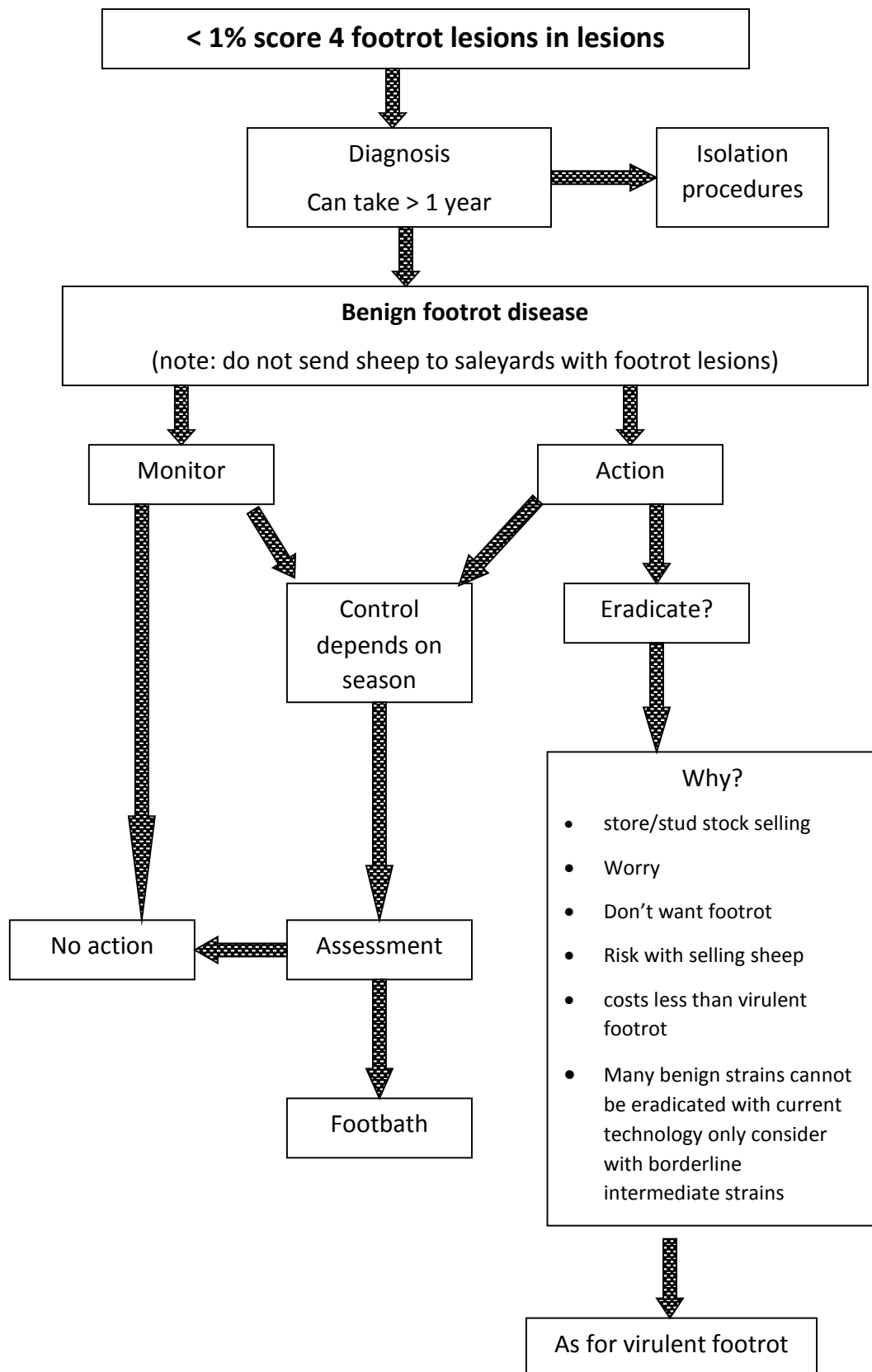


FIGURE 4 FLOWCHART FOR DEALING WITH BENIGN FOOTROT

How Do I Deal with Virulent Footrot?

Farmers who have sheep diagnosed with virulent footrot can only take one course of action - eradication (Figure 5).

A farmer who fails to take any action to deal with virulent footrot, or tries to hide the problem, is unfairly placing neighbouring flocks at a high risk of infection.

Depending on which state, the state Department of Agriculture will enter into a control/eradication agreement with the owners of the affected flocks.

Most farmers want to act quickly once virulent footrot is diagnosed, but hasty decisions and actions can be counterproductive. For example, it is unlikely footrot can be eradicated in spring, it is better to wait until summer. During spring, the disease is still spreading from sheep to sheep and you might be chasing your tail. In contrast, during summer or any period that is very dry the footrot bacteria is not spreading from sheep to sheep, making eradication simpler.

While eradication programs can vary from farm to farm to suit individual needs, they all have four basic stages:

1. **Planning**
2. **Control**
3. **Eradication**
4. **Surveillance**

1. Planning

A common reason for an eradication program failing is due to a lack of planning. The lack of hard work is often not the cause of footrot eradication failure. The poor direction of this hard work is a prime cause. A feasible detailed program is essential, as is an open, honest relationship between the farmer and adviser/contractor. A good plan includes consideration of the farm's facilities as well as the management, flock structure, labour and finances required to control footrot.

An important priority should be to eliminate any source of re-infection. This includes securing all boundary fences. There is no point in attempting an expensive eradication program if your sheep are quickly re-exposed to infected stray sheep from neighbouring properties. In this situation, control should be considered. Once the source of infection is eliminated, eradication can be considered.

2. Control

Footrot needs to be controlled during the spread period so the infection in the flock is reduced to a level where eradication is feasible. The aim of control is twofold. Firstly, to have as few infected sheep as possible at the start of the eradication stage. Secondly, control is necessary to prevent production losses and for the welfare of the sheep.

Good control of footrot is essential to eradicate the disease. When good control is achieved, very few sheep with severe lesions are found at the summer inspections. Because of these low numbers, it's an easy decision to cull the remaining infected sheep.

Footrot spreads during warm, wet periods, typically in spring, but the exact timing of spread periods varies from season to season and between districts. A sign that spread is occurring is when some sheep have red, active looking Score 1 and 2 feet. The severity of lesions in these feet will rapidly worsen.

Control during a spread phase is achieved by either vaccination or regular footbathing or a combination of both. The choice between control methods is very complex so seek expert advice. Note that commercial vaccines are currently not available although there is limited availability of vaccine developed through Sydney University that requires initial culture and serotyping of footrot strains to determine the strains that need to be incorporated in the vaccine for individual properties.

Footbathing is the most commonly used option for the control of footrot. Used alone, footbathing can reduce the severity of infection and number of sheep infected during the spread period but will not eradicate footrot. It also assists healing in feet that are already affected.

This does not eliminate the need for foot inspection of ALL sheep during the non-spread period.

Footbathing in a footrot control program has the following roles:

- Treatment of existing footrot lesions and reduce the spread of footrot to improve chances of summer eradication.
- Improve health, welfare and production of sheep.
- Precautionary quarantine treatment for introduced sheep. (note very unlikely to eliminate existing infection but may act as superficial disinfectant to reduce the risk of bacterial pick up from transport)

There are two options for footbathing for footrot control.

Short term (walkthrough or stand in for up to 5 minutes):

1. 10% Zinc Sulphate solution is used to treat sheep every seven days as a walk-through treatment in a footbath at least 8 meters long.
2. 5% Formalin is used to treat sheep every seven days as a walk-through treatment in a footbath at least 8 metres long. There are serious workplace health and safety problems associated with formalin so it is generally not recommended.

Walk through footbathing is effective against score 2-3a lesions and must be done weekly.

Long term (stand in footbath for 15 to 60 minutes)

1. Footrite® (20% Zinc Sulphate solution) suggested to be used every 2-3 weeks (Note Footrite is currently not available)
2. Radicate® is a solution of copper salts used for footbathing every 2 weeks for 15 minutes. Consult your adviser for further information.

If done properly, footbathing alone can be very effective. However, most farms, especially with large numbers of sheep find footbathing very time consuming and is not practical for ewes with lambs, especially during the spring spread period.

Vaccination

At the time of writing there was no Footrot vaccine available in Australia. There has been previously Footvax® a killed multi-serotype (strains A-I) vaccine and there is expected to be a strain specific killed monovalent or bivalent strain vaccine currently undergoing registration.

Footvax® was registered to aid in the control of footrot in sheep. Effective vaccination can provide a protection rate of up to 80% of the flock and cure around 60% of infected sheep. Following two vaccinations, sheep are protected against footrot for up to 10-12 weeks for merinos and up to 16 weeks for British breeds.

The new mono/bivalent property specific vaccination relies on identifying the footrot strains specific to a farm, then a specific recombinant vaccine against one or two strains can be produced. This provides greater immunological response and may reduce the requirement for footbathing and the numbers to cull over summer. The drawback to this technique is that the initial identification of the strains can be expensive and there maybe more than two strains present on many farms requiring multiple rounds of vaccination.

The inability of any vaccine to give total protection or cure all affected sheep, means vaccination is only part of a well-planned footrot program.

Vaccine use is extremely valuable in situations where sheep cannot be footbathed regularly, such as with lambing ewes, extensive properties where mustering is difficult or any property where labour shortages or facilities preclude effective footbathing.

In flocks where eradication is not possible due to the ongoing risk of stray sheep due to poor boundary fences or common grazing, vaccination may need to continue on an annual basis during the spring spread period.

The recommended vaccination site is under the skin behind the ear to minimize carcass damage.

3. Eradication

The aim of the eradication phase is to identify and remove all the remaining infected sheep from the flock when footrot is not spreading. Removing all infected sheep prevents them re-infecting the clean sheep during the next bout of warm, wet weather.

A quick inspection of sheep's feet will show when a spread period is drawing to a close - the feet start drying up and the skin between the claws is not as red or moist. Eradication is best carried out during the hot, dry summer months.

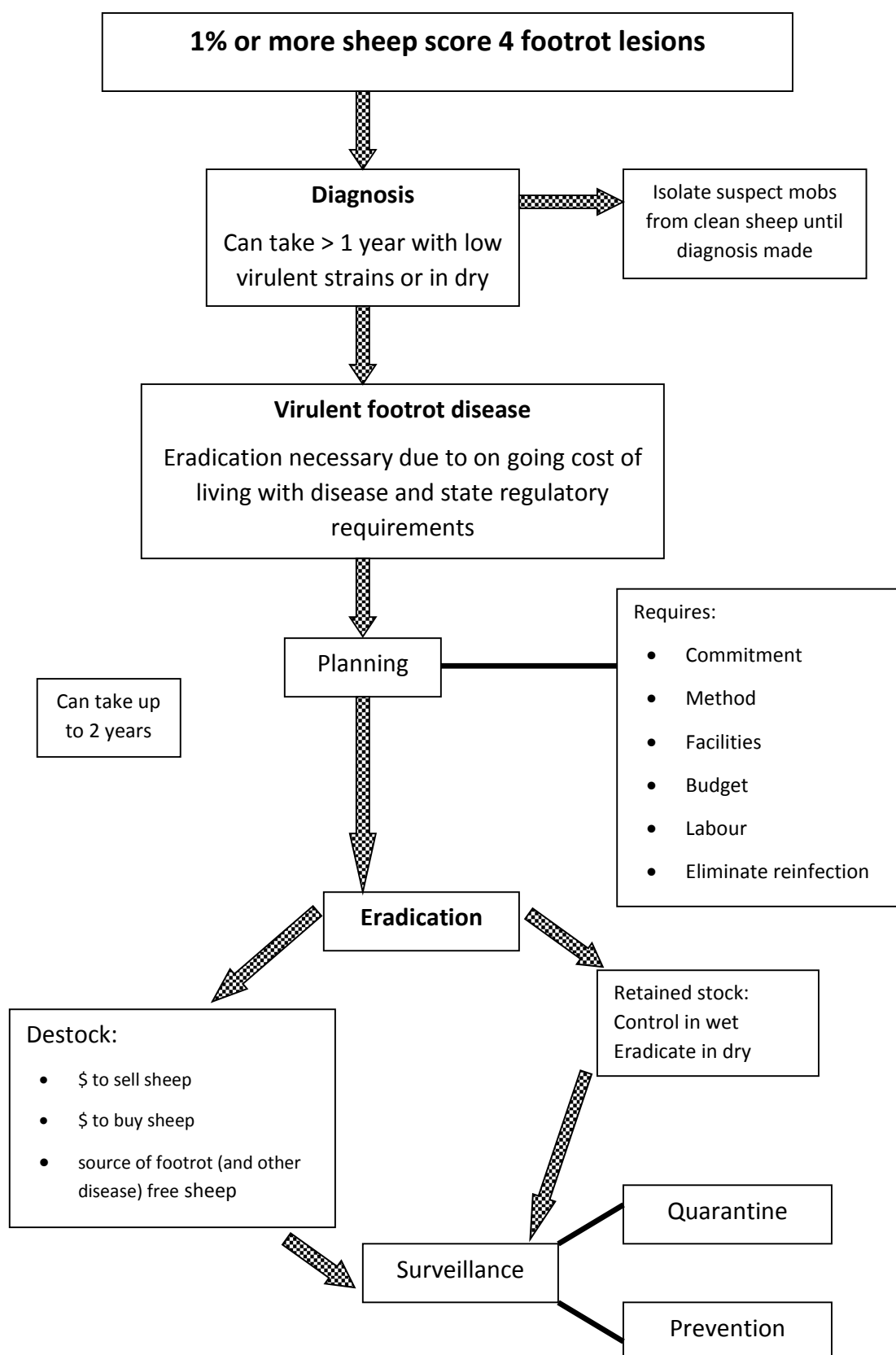


FIGURE 5 FLOWCHART FOR DEALING WITH VIRULENT FOOTROT

* In periods of drought footrot may not express itself properly. The final diagnosis may not be made until conditions are suitable for disease expression.

Eradication is accomplished only by the repeated inspections of all feet on all sheep. Ideally, two clean inspections, without finding any footrot affected sheep, are needed. This means inspecting all feet on all sheep at least three times before the autumn break.

Before starting a footrot eradication program, you should be aware of the chances of successful eradication of the disease in individual mobs and on the property as a whole. Eradication may not be accomplished from all mobs in a single year, although it is preferred.

Successful control is critical with footbathing (and possibly vaccination) to increase the likelihood of eradication and reduce the number of sheep that have to be culled.

A considered and definite commitment to the program, in terms of both time and money, must be made. Half measures will waste time and money and are unlikely to be successful.

Other property work must be altered to revolve around the footrot program. Don't put off an inspection to do something else.

Time is the limiting factor; a minimum three to four months is required for a complete program. Since the non-spread periods are relatively short (three or four months), inspections must begin early and must not be drawn out. Attention to detail is vital.

Inspections can be done by farm staff or by contractors. Realistically, accredited contractors should be used on properties where labour resources are limited. A sheep handling machine and air operated footparers are essential. Inspecting sheep is easier, faster and much more accurate if the good equipment is used. The next inspection has to start 4-6 weeks after the last one started.

In most circumstances, eradication from the entire property is preferred however if your property is physically divided, for example by a road, it may be better to concentrate your resources on eradicating footrot from a portion of the flock in the first year. Absolute separation of both groups is essential at all times, such as during shearing or dipping. All sheep must be considered as part of the program.

GENERAL REQUIREMENTS

Look for four normal feet. Only keep sheep with four normal feet. All remaining sheep with footrot or doubtful feet should be culled for slaughter. Some of these sheep may have conditions other than footrot but keeping these sheep may cause eradication failure.

Inspectors must be well trained and people inspecting feet must not rush inspections.

If a small percentage, usually less than 10%, are infected, they should all be culled. If more than 10% are infected, or if the sheep are particularly valuable, it may be worth trying to salvage them with antibiotic treatment combined with paring and footbathing.

There is a risk associated with treating infected sheep - the longer infected sheep remain on the property during the eradication phase, the greater the risk of the program failing.

Salvaging sheep with antibiotics is an option when a high percentage of the flock is affected with footrot, especially when spring control has failed. The decision to use antibiotics in an eradication program must be made in consultation with your veterinarian.

Antibiotics will not cure all sheep affected with footrot - animals which do not respond to the antibiotic treatment must be culled. To be effective with antibiotic, must only be injected when feet are dry for 24 hours after treatment (eg. on battens) especially when combined with footbathing.

Foot paring is done for two reasons only:

- A **diagnostic pare** to allow cleaner inspection of the foot and may open pockets of infection.
- A **cosmetic pare** where the foot is reshaped for welfare reasons and to make subsequent inspections easier when infected sheep are treated with antibiotics.
- Note that foot paring should only be done to aid diagnosis and only lightly so not to cause bleeding and obscure the foot.

Foot paring has a minimal effect on the cure rate when injectable antibiotics are used. Paring with the foot cut to pieces and bleeding profusely is not humane and has no role in eradication. Mutilation does not increase the success of eradication.

Branding sheep (with approved scourable brand) as they are inspected, treated and reinspected is an important part of the eradication program. Branding ensure no sheep are overlooked to undermine the hard work involved in eradication.

All sheep that have been inspected "clean", should be clearly identified. Footrot, cull and suspect sheep must be identified - brand them on the head with a different colour. On the second inspection, sheep can be branded on the middle of the back and on the third inspection they can be branded on the rump. Any sheep without a brand should be closely inspected.

a) The first inspection

The first inspection should be carried out as soon as weather conditions and pastures have dried up sufficiently to halt the spread of footrot.

This is usually after hay making is completed. In cooler high rainfall regions, conditions may not be suitable until late December or January.

Sheep should have their feet inspected on a sheep handling machine. Individual sheep may or may not be foot pared depending on the condition of their feet. Minimal paring may be done to make inspection easier or cosmetically reshape the foot. Paring only needs to be done to ensure the feet are normal.

If you have to trim the foot extensively to make a decision then treat that sheep as infected.

IF IN DOUBT - CHUCK IT OUT

If you have large numbers of sheep suspected of having footrot and decide to treat and salvage these animals rather than culling them, then it is safer, cheaper and faster to treat these difficult sheep than it is to waste time paring their feet.

All sheep should be branded as they are inspected and cull sheep should be given a second distinguishing brand.

Salvaged sheep are treated with antibiotics on the sheep handling machine and should be held overnight on a dry slatted floors in the wool shed. Salvaged sheep must be run in a separate mob.

Footbathing is generally not recommended but may be used in certain circumstances after discussions with the farm adviser.

b) The second inspection

It is preferable to run the previously clean sheep in and inspect before treated/salvaged mobs. All sheep should be given a second inspection four weeks after the start of the first inspection.

The inspection process is the same as the first inspection - a minimum level of paring is used, feet only trimmed enough to make a diagnosis. Sheep are branded on the middle of the back as they have been inspected.

ALL FEET ON ALL SHEEP must be inspected with no distinction being made between treated salvaged sheep and previously "clean" sheep.

Cull all sheep that do not have four perfectly normal, healthy feet at the second inspection.

NO SHEEP ARE TREATED FOR SALVAGE at this or later inspections.

Brand cull sheep with a clear, distinguishing mark so there are no mistakes and send them for slaughter.

c) The third and subsequent inspections

The third inspection is carried out four weeks later. The procedure is the same as the second inspection and all suspect sheep are culled.

As a guide, up to 1-2% of suspects can be found at the second inspection (or 5-15% if they are a mob that have been salvaged) and about five per thousand (0.5%) at the third inspection. If more than this number is found then the management of the footrot eradication program needs to be reassessed, especially the inspection technique.

Regular inspections must continue until there have been two successive, totally clean inspections of each mob. The number of inspections may vary between mobs, so good records are essential.

The second clean inspection may be delayed until after the autumn break, but must be completed before footrot starts to spread.

With all inspections it is imperative to thoroughly check paddocks to avoid missed sheep. This can be a potential source of failure of the program.

Hygiene during inspections

Clean or low risk mobs should always be inspected **first**. At the second inspection always inspect mobs that were previously diagnosed as clean first. It is probably a good idea to dip foot parers in Hibitane™ or chlorhexidine after an infected sheep is detected, though not necessary at earlier inspections. Sheep handlers, specifically the loading race should be washed down thoroughly with disinfectant between properties.

4. Surveillance

Surveillance and monitoring are essential once a mob has gone through the intensive control and eradication program to ensure footrot has been eradicated and to prevent reinfection.

You can only be confident footrot is eradicated once all sheep have been through a good spring spread period without any evidence of footrot.

a) Isolation

It is important to keep all mobs isolated until they have gone through the following spring spread period. If you are concerned about visitors leaving gates open, then lock the gates.

All sheep must be regularly observed and any lame sheep must be examined. Monitoring the mobs should become routine until the end of spring.

If any suspect sheep are found:

- Isolate the mob that are suspect and have them examined.
- Do not cross any other mobs behind the suspect mob in yards, lanes, sheds, etc.

b) Routine Handling

Routine management procedures such as drenching, marking and jetting must be done in the paddock or stagger stock movements at weekly intervals through yards. Crutching, using a cradle system, can be done very efficiently in the paddock. If you use portable yards, don't put them in the corner of 4 paddocks and cross mobs over.

c) Footbathing following eradication

It is best not to footbath sheep following an eradication program. Surveillance during the next spread period is critical to detect any breakdowns. Footbathing should only be performed on the advice of your consultant. Normally, it's only recommended when the program has been interrupted and there is a high chance that it may fail.

d) Final audit to confirm footrot eradication

After a spring spread period managers may decide to inspect all mobs (or part thereof) to ensure footrot eradication has been successful. This is especially important if the spring period has been dry or the strain eradicated is of low virulence. Figure 8 summarises the sequence of events during footrot eradication.

Eradication by destocking

In some cases, the sale for slaughter of all the sheep in an infected mob, spelling the property for at least seven days and then restocking with clean sheep the best way of eradicating footrot.

If only one or two mobs on a property are affected by footrot, then the early sale of these sheep can remove the risk of the disease spreading to other mobs on the property.

The cost associated with this approach is the change over price of the sheep involved. This will be determined by the market value, genetic merit and age of the sheep, the availability of footrot-free sheep, transport costs and treatment costs.

Detailed investigation to ensure new sheep are footrot free is critical. Apart from inspection, new sheep should come with an Animal Health Statement for their disease status including footrot and other diseases such as OJD, and lice.

The sale price of sheep with footrot is usually low because they can only be sold for slaughter and often have a reduced bodyweight. If the footrot-infected sheep have inherently low productivity, then replacing them with clean sheep with a highly productive genotype can greatly improve the profitability of the farm and offset the initial capital outlay for new stock.

The cost of selling and buying stock must be weighed up against the cost of a control/eradication program. Selling infected sheep and restocking may be cheaper than an eradication program which fails.

Before making a decision about destocking it is important to consider the farm resources and budget.

Eradicating footrot by destocking is worth considering when:

- A farmer is unwilling or unable, to commit the labour or resources required to set up a proper eradication program.
- One or two mobs on the farm are infected.
- The footrot-infected sheep are at the end of their productive life.
- Sheep prices are low, for example during a drought, so the changeover costs are reduced.

The type of farm operation and the number and size of mobs involved have a big bearing on the decision to destock. Part-time farmers with relatively small flocks may find destocking effective if they cannot commit the time required for a footrot eradication program.

The tax burden of a forced sale of footrot-infected sheep may be minimized using Farm Management Deposits and taxation concessions may be available, but it is necessary to consult with your accountant or financial adviser before making decisions.



FIGURE 6 A LIGHTLY PARED FOOT READY FOR INSPECTION

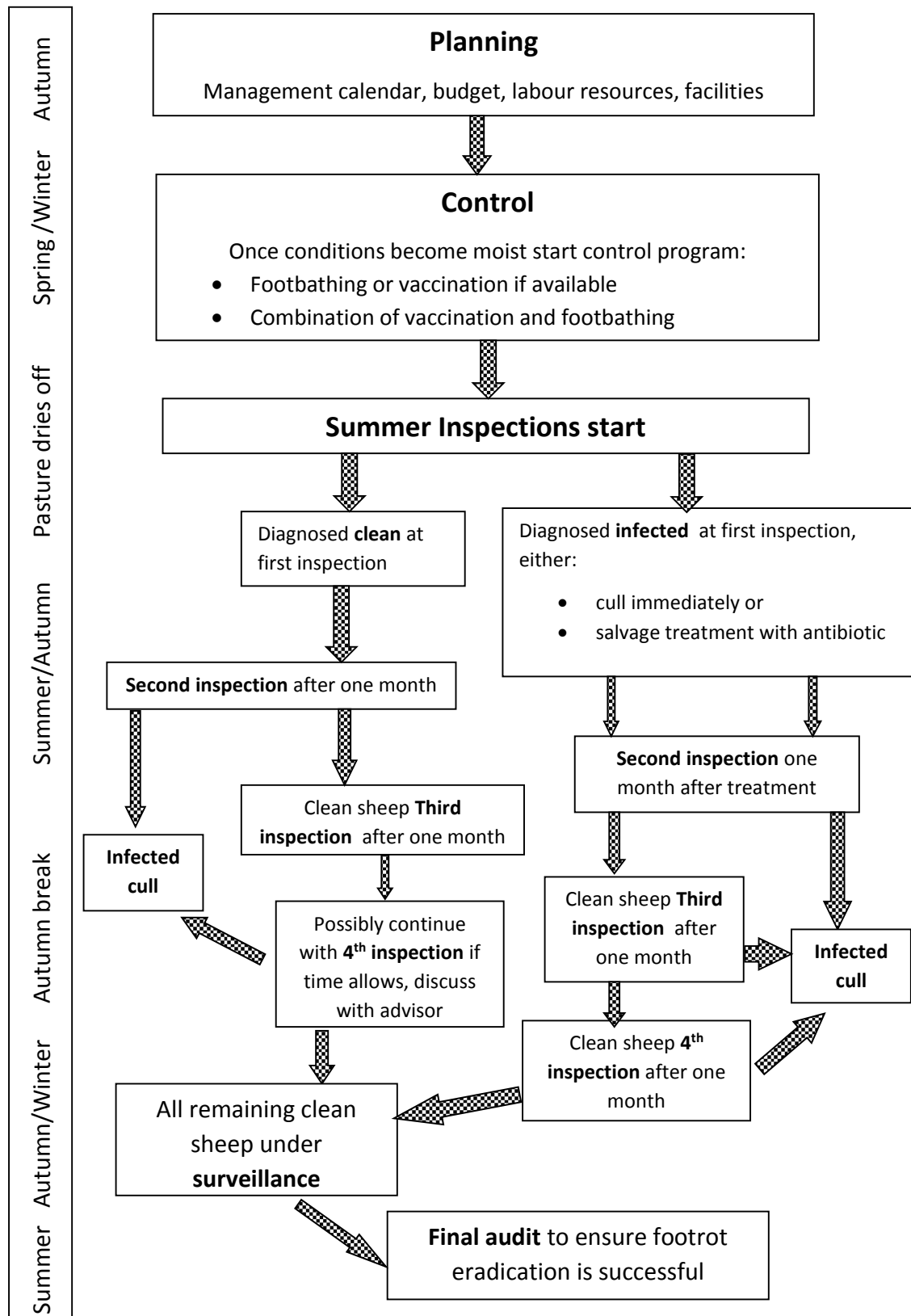


FIGURE 7 SEQUENCE OF EVENTS DURING ERADICATION OF FOOTROT BY INSPECTION AND CULLING

The Cost of Footrot

Virulent footrot can have a huge impact on the viability of sheep farms, especially if not managed properly. The costs associated with footrot not only include the direct production losses, but also indirect costs associated with the disease and control and eradication costs.

Direct costs:

- Lower wool production (up to 10% lower but typically 3% with some control and 2% with intermediate footrot)
- Lower fibre diameter (drop by up to 0.5 micron)
- Reduced staple strength (up to 10% lower)
- Fleece value 4-5% lower
- Body weight (up to 12% lower but typically 5% lower with some control program adopted and 2.5% with intermediate strains)
- Conception rates reduced by 1.5% per kg bodyweight. Lower estimates of the economic losses due to lost production will typically be over \$5.00 per head in sheep with no control whereas losses may be negligible in sheep when footrot is properly controlled
- Footrot control with footbathing often costs about \$1-2.00 per head depending on frequency of footbathing. Vaccination, whilst not widely available at present is likely to cost over \$2.00/dose
- Eradication typically costs over \$5.00/head depending on labour costs

Secondary costs:

- Lower body weight will increase supplementary feeding and reduce ewe fertility (5-10% lower lambing percentage)
- Low lamb body weights will increase weaner illthrift in summer, increase lamb death rates and lower the value of prime lambs
- Metabolic diseases: higher ewe death rates due to pregnancy toxemia and hypocalcaemia
- Fly strike risk is greater due to covert fly strikes building up fly population, associated increase in chemical control and higher death rates

Indirect costs:

- Less sale opportunities
- More difficult management, such as dealing with weaner illthrift
- Farmer stress leading to poor decision making

- Lower stocking rate is potentially the greatest cost
- Estimates of the indirect cost of living with footrot may typically up to \$5.00/head per year, but could be higher in situations where stock sales are severely penalised.

The cost of living with footrot on a 5,000 head property may be over \$25,000/annum or over \$5.00/head. This includes a conservative estimate of lower production at \$1.00/head (assuming good control), with Indirect costs of \$2.00/head and control costs of \$2.00/head. The production losses will be far greater if no money is invested on control costs.

The cost of control

The cost of control will depend on the method used. For example, let's consider a situation where control is required for 16 weeks over the late winter and spring period in a merino flock infected with virulent footrot using a weekly walk through footbathing in 10% Zinc Sulphate (say 10 footbaths).

The cost of weekly footbathing will be about \$0.10/head in chemical cost and labour varying between nothing up to \$0.10/head/footbath, depending on labour availability and how the farmer values labour. Let's assume labour cost of \$0.06/head/footbath and footbathing facilities already exist. The control cost in this situation will be 10 footbaths at \$0.16/head or \$1.60/head.

From a logistics point of view footbathing will not be completed properly with spring lambing ewes and on a property with limited labour a footbathing program may not be completed. These factors must be considered when deciding which control option to use. Vaccination may provide an effective alternative in future if it becomes available.

These control cost may seem excessive, but compared with production losses, the cost are a good investment if adopted properly.

In addition to minimizing production losses, the cost of eradication will be significantly reduced due to lower inspection costs and less need for salvage infected sheep. For example, a flock with 15% infected at the first inspection is estimated to take about 20% less time to inspect compared with a flock with 30% infected. This would give an immediate saving of \$0.25/head in inspection cost and \$0.15/head saving for antibiotic treatment cost, giving a total saving of \$0.40/head. The

critical factor too, is that the likelihood of eradication increases as less sheep are infected at the start of the summer program.

The cost of eradication will be at least \$5.00/head, depending on whether contractors are employed or is it is completed by farm employees. During eradication the total cost of footrot will be over to \$10.00/head. Whilst this is a large cost and a major investment, the ongoing cost of living with footrot is unacceptable for serious commercial sheep producers.

Biosecurity: Keeping footrot off the property

Footrot prevention is an essential part of the management on any sheep property.

Controlling footrot is a major exercise - once the disease has been eradicated from a farm, it is important to take precautions to stop footrot being reintroduced.

The risk of reintroducing footrot can be minimised if you:

- Maintain good fences. Good internal and boundary fences are the best defence against the introduction of footrot. They should be maintained in stock proof condition. That means not just your sheep but for the neighbours' cows and goats as well.

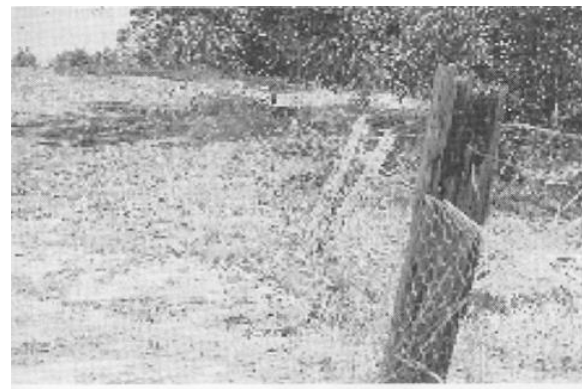
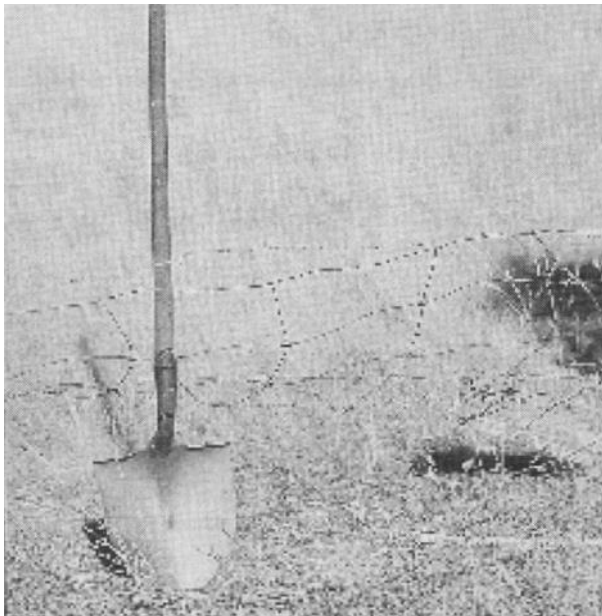


FIGURE 8 WOULD THESE FENCES KEEP FOOTROT OFF YOUR PROPERTY?

- Remember sheep are a source of infection. All sheep or goats coming onto the property must be regarded as suspect and as a source of infection. RAMS are a common source of infection. Being a "stud" does not mean they are free of footrot. Beware of strays, including sheep that have strayed off your property – quarantine them – or cull them.
- Monitor purchased sheep. All sheep coming onto the property must be kept isolated as a mob until they have been through a spread period, usually the following spring. Check all lame sheep. Ideally, all sheep are individually inspected on arrival and if a problem is detected it can be immediately acted upon.
- Buy sheep with a vendor declaration/Sheep Health Statement.
- Use footbathing in an appropriate way. Footbathing all introduced sheep will act as a superficial disinfectant – it will not cure chronic lesions.
- Would these fences keep footrot off your property?
- Preferably inspect all new sheep on arrival and hold in strict isolation until they have been through a spring spread period.
- Realise the role of cattle in spreading footrot. Benign strains of footrot can actually infect cattle and are readily transferred by them. Virulent strains of footrot can also be mechanically spread by cattle. Overall the role of cattle in the spread of footrot is unclear but probably seldom occurs.
- Consider the role of goats on the property. Footrot does not behave the same way in goats as it does in sheep. The bacteria which cause mild forms of footrot in sheep cause severe damage to goats' feet. The strains of footrot are hard to distinguish by examining numbers of goats. Goat movements must be considered in a footrot eradication plan.

Acknowledgments:

This manual was originally written by staff of the Mackinnon Project, Including Dr Graham Thompson (Editor), Dr David Counsell, Dr Graham Lean, Dr Colin Scrivener, Dr Andrew Vizard and Dr John Webb Ware in Conjunction with Department of Primary Industry (Vic) staff including Dr John Larsen for the Footrot focus group project. Mr Richard Keys (DPI Vic) provided some photographs.

Exercise: YOUR ERADICATION PLAN FOR FOOTROT

Under each of the 4 headings listed below, describe the key factors and established actions you need to consider when trying to eradicate virulent footrot on farm.

1.Planning

2.Control

3.Eradication

4.Surveillance

Appendix 1: 10 COMMONLY ASKED QUESTIONS ABOUT FOOTROT

1. How long does footrot last in the ground?

Research has shown that the footrot bacteria will not survive for more than seven days in the ground. A seven day spelling period is advised to ensure no risk of spread.

2. What's the purpose of vaccinating for footrot?

If you don't have footrot on your farm then don't vaccinate. The vaccine does not completely prevent or cure the disease. The footrot vaccine (Footvax multivalent vaccine) was a very useful aid in controlling the spread of the disease in infected flocks. Vaccination is not used in flocks infected with benign footrot. Footbathing will give adequate control in this situation. New vaccines incorporating 1-2 serogroups per vaccine depending on strains present on farm may provide a useful control option if it becomes commercially available in future.

3. Does vaccination mask the disease, therefore reduce the ability to eradicate footrot?

Vaccination does not mask footrot and does not reduce the chances of footrot eradication. In fact a properly designed control program will increase the likelihood of eradication because less sheep will go into summer with clinical footrot lesion resulting in easier inspections, less reliance on antibiotics to salvage sheep, culling of infected sheep and lower chances of missing infected sheep.

4. Can feral animals, kangaroos, gumboots and motorbikes spread footrot?

Virtually impossible. Footrot is likely to be introduced onto a property from straying sheep, a recently purchased infected ram, or that bargain mob of wethers purchased at the last sale. Car tyres, foxes and kangaroos are of minimal or no importance in the spread of footrot. It is best to disinfect boots when moving between infected and clean mobs.

5. Should I inject all my sheep with antibiotics to get rid of footrot?

No. However, antibiotics can be a terrific aid to footrot eradication for salvaging sheep when the flock has more than 10-20% affected at the start of summer. Antibiotics don't cure 100% of footrot affected sheep - they are not a one shot magic cure. The hard work of pulling out the remaining affected sheep still must be done. Antibiotics are only effective when conditions are very dry and are an aid for salvaging sheep during footrot eradication. Antibiotics can only be used under the guidance of your veterinarian.

6. It's not footrot, it's just a bit of 'scald', isn't it?

Rather than being hesitant about lame sheep, it's time to get an expert diagnosis as soon as you see them. Different strains of the footrot bacteria cause footrot of differing severity ranging from mild to severe lameness. Many producers make poor decisions and face unnecessary anxiety and stress by not diagnosing the cause of lameness. Recognizing a footrot problem is the first step to management and eradication. Start calling footrot, **FOOTROT!** Seek advice to determine if the strain present is benign or virulent.

7. Do I have to pare the feet heavily to get rid of footrot?

Paring alone does not get rid of footrot. The major role of paring is to enable you to inspect the feet. Once you are happy all four feet are normal then a sheep is considered clean. If a sheep does not have four normal feet, it should be culled. A common mistake is to pare too heavily which causes bleeding and obscures the feet making it more difficult to make an accurate diagnosis.

8. Why can't I cure my sheep with severe footrot lesions?

A common mistake with farmers trying to eradicate footrot is that they concentrate on the infected sheep. This is the wrong approach. Farmers should concentrate on all mobs including provisionally clean mobs to identify and cull any infected sheep.

9. Will treatment of my sheep with Copper or Zinc help get rid of footrot?

No. It is a common misconception, and totally incorrect, to expect that top dressing pasture or drenching sheep with trace elements will eradicate footrot. Footbathing in Copper Sulphate will stain wool and this may decrease in wool value.

10. Can cattle give my sheep footrot?

Benign strains of footrot can infect cattle and are readily transferred by cattle. Virulent strains of footrot can be mechanically spread by cattle, probably only when conditions are wet. However, the role of cattle in the spread of virulent footrot is still unclear and probably occurs very infrequently. Cattle do not appear to be capable of carrying virulent strains of footrot for long periods so do not affect the success of eradication when conditions are dry.

Appendix 2: State Laws Governing Footrot

Footrot of sheep and goats is a scheduled disease under disease control legislation. This means that:

- outbreaks of footrot must be notified to an Inspector of Livestock
- it is illegal to sell infected sheep or goats other than for slaughter
- it is illegal to place footrot infected sheep in or adjacent, to any saleyard or in any public place (including a road)
- infected sheep must be treated
- Inspectors of Livestock have the power to test and restrict movement of infected or suspect sheep and to ensure treatment is carried out.

Search the internet or talk to your local department of primary industries office to find relevant state law regarding footrot.

Disease Watch Hotline - 1800 675 888

Appendix 3: Process for specific (target) vaccination in Australia

1. Accurate identification of the serogroup(s) of *D. nodosus* that are present in a flock and that are associated with virulence. This is achieved by collection of lesion material and testing for serogroups and virulence.
2. Production of specific vaccine containing no more than 2 serogroups appropriate for the flock.
3. Whole flock (including lambs) vaccination with 2 doses of specific vaccine.
4. Culture of non responders to identify additional serogroups present in the flock.
5. Culling of vaccine non-responders if the numbers are small and if no additional serogroups are present.
6. Revaccination with a 2nd vaccine after three months to cover remaining virulent serogroups (if present). This is repeated every three months until all serogroups associated with virulent disease have been eradicated.
7. Confirmation of eradication by clinical examination and laboratory tests.
8. Following of strict biosecurity/quarantine measures to prevent re-entry or new infections into the flock.