



WORM CONTROL PROGRAM

South Australian winter rainfall

A regional worm control program from WormBoss





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WormBoss worm control program

South Australian winter rainfall

Program summary

The WormBoss worm control program for the South Australian winter rainfall region has five components that are most effective when used in combination.

A summary of the components is below (see further chapters for details).

1. Use grazing management to create low worm-risk paddocks

- Prepare weaning and hogget paddocks using rotational grazing with sheep; a non-sheep use in at least the 6–8 weeks prior to introducing weaners or hoggets (grazing paddocks with cattle, cropping, haymaking, new pasture establishment); grazing with adult sheep that have a tested low worm egg count (less than 50 epg); or grazing with sheep up to 30 days after the protection period (when killing worms) of an effective drench.
- Choose the least contaminated lambing paddocks for the most susceptible lambing ewes (maidens, oldest ewes and earlier lambing ewes).

2. Breed and feed for worm-resistant sheep

- Use rams with better than average worm egg count (WEC ASBVs¹) and, if applicable to your area, less dag (DAG ASBVs); choose the more negative values for both.
- Maintain good nutrition to enhance the sheep's immunity to worms.

3. *WormTest* at recommended times (see description of zones on next page)

- *South-East*
 - Lambs 4 weekly from 12 weeks to turnoff if they are still on their mothers.
 - Weaners 4 weeks post-weaning then 4–6 weekly until the end of their second (hogget) winter.
 - Ewes pre-lambing, pre-marking and pre-weaning/6–8 wks after marking if weaning is at turnoff.
 - Ewes 6–8 weeks after the 'summer drench' then 8 weekly until pre-lambing.
- *Higher Rainfall Mediterranean*
 - Lambs 4 weekly from 12 weeks to turnoff if they are still on their mothers.
 - Weaners 4 weeks post-weaning then 4–6 weekly until the end of their second (hogget) winter.
 - Ewes pre-lambing, pre-marking and pre-weaning/6–8 wks after marking if weaning is at turnoff.
 - Ewes 8 weekly from when the feed is drying off until pre-lambing.
- *Lower Rainfall Mediterranean*
 - Lambs just before weaning.
 - Weaners 6 weeks post-weaning then 6 weekly on green pasture, 8 weekly on dry pasture or 10 weekly on crop stubbles until the end of their second (hogget) winter.
 - Ewes pre-lambing.
 - Ewes pre-weaning only if more than 10% of ewes are scouring.
 - Ewes just before harvest then in a further 10 weeks (on pastures) or when they come off stubble.
- **And at other non-routine times as described in the *Drench Decision Guide*.**

4. Drench² at recommended times (see descriptions of zones on next page)

- Lambs at weaning (only South-East and Higher Rainfall Mediterranean zones).
- Working rams pre-joining.
- The 'summer drench' in late November/December 3 weeks after feed dries off (only South-East zone and Higher Rainfall Mediterranean zones).
- Drench all introduced sheep with a combination of no less than 4 unrelated drench actives with at least one of these being the newest drench actives: monepantel (Zolvix®) or derquantel (with abamectin—Startect®)³.
- At other times, use the *Drench Decision Guide* and *WormTest* results to make drenching decisions.

5. Manage drench resistance

- Conduct *DrenchTests* each 2–3 years and use *DrenchCheck-Day10s* in between.
- Avoid unnecessary drenching.
- Use effective drenches and multi-active³ combinations where possible.
- In general, use short-acting treatments and restrict the use of long-acting products to high worm-risk periods, and seek expert advice on their use.
- Rotate among all effective drench groups³ for each mob (and each paddock where possible).
- Calibrate your drench guns, dose to the heaviest sheep and follow label instructions.

¹ ASBVs=Australian Sheep Breeding Values. ² Drench refers to worm treatments regardless of route of administration.

³ Drench groups are the chemical family to which an 'active' belongs. An 'active' is the chemical in a drench responsible for killing worms. Some drenches contain more than one active and are called 'multi-active' or 'combination' drenches. See [Appendix 2: Drench groups and actives](#).

This is an up-to-date, integrated regional worm control program for sheep in the South Australian winter rainfall region. It builds upon earlier programs and accumulated knowledge, including from the former Department of Agriculture WormCheck program and the experience of researchers, consultants and advisers, as well as new information from the Integrated Parasite Management in Sheep project, funded by Australian Wool Innovation and 'Parasite control in southern prime lamb production systems', funded by Meat and Livestock Australia.

The program aims to improve the profitability and welfare of your sheep through:

- fewer deaths and illness from worms
- fewer drenches, particularly long-acting drenches
- improved productivity
- prolonged life of drenches

For more information go to the WormBoss web site: www.wormboss.com.au

Where is the South Australian winter rainfall region?

In South Australia, there are 3 zones within the winter rainfall region. Information for these 3 zones is in this publication.

In addition, there is a much drier Pastoral zone, covering areas to the north of the Lower Rainfall Mediterranean zone (generally north of Goyder's line), and for which information on worm control is in the separate publication: WormBoss worm control program, Pastoral.

The South-East zone

This zone is the south-eastern corner of the state below an approximate line running from Kingston SE to Bordertown, through to the Victorian border. The zone generally receives more than 550 mm annual rainfall. Although summers are warm, effective summer rainfall episodes (12mm or more) are not unusual, especially towards the coast. Pastures sometimes retain a substantial green component over summer.

The Higher Rainfall Mediterranean zone

This zone has the following areas:

- Kangaroo Island
- The southern tip of the Eyre Peninsula below Cummins
- Fleurieu Peninsula and the Adelaide Hills
- Clare Valley

Usually this zone receives more than 450 mm rainfall per year (though some areas are substantially higher) and summers are generally hot with no effective rainfall. Cropping can be a component of the enterprise mix.

The Lower Rainfall Mediterranean zone

This zone is north of the Higher Rainfall Mediterranean zone and extends to a line running from Ceduna across the Eyre Peninsula to between Cowell and Whyalla, then from around Port Pirie to south of Port Augusta, Orroroo and Peterborough, then east or north of Burra, Mannum, Karoonda to near Pinnaroo. This corresponds to Goyder's line in many places.

It typically receives less than 450mm rainfall per year and summers are usually hot with no effective rainfall. Cropping is a substantial component of the enterprise and most properties have stubbles or crop residues available for grazing.

The boundaries for these zones are approximations only as seasonal temperature and rainfall variations affect worms.

A map of the region is shown on the next page.

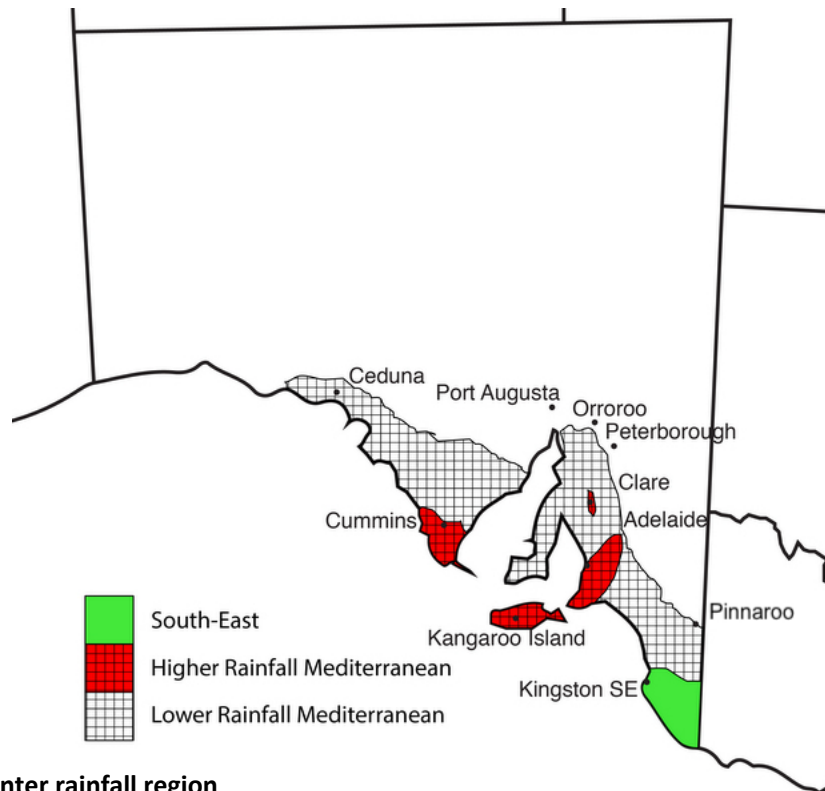


Figure 1. South Australian winter rainfall region

What worms are covered in this program?

Roundworms

The most important roundworms in this region are:

- Scour worms
 - ♦ Black scour worm *Trichostrongylus vitrinus*
Trichostrongylus colubriformis
 - ♦ Small brown stomach worm *Teladorsagia (Ostertagia) circumcincta*
 - ♦ Thin-necked intestinal worm *Nematodirus spp.*(only in young sheep)

In some or most years around Willalooka, Mundulla, Keith, Tintinara, Strathalbyn Plains, Adelaide Hills, Fleurieu Peninsula and coastal areas as well as isolated properties in the lower south east:

- Barber’s pole worm *Haemonchus contortus*

Very wet years generally cause higher burdens of all worms. These can be fatal without scouring occurring.

Barber’s pole worm

In this region, barber's pole worm is generally sporadic and of short duration, therefore the Barbervax® vaccine is unlikely to be needed or cost-effective compared to 4–6 weekly monitoring of worm egg counts during high risk periods and treatment with a short-acting drench or closantel.

However, if your farm has periods of high barber's pole worm risk for several months each year (which may occur in coastal areas or on irrigated pastures) seek professional advice as to whether the Barbervax vaccine program should be considered.

Liver fluke

Liver fluke is an internal parasite that occurs in limited parts of South Australia, but is usually associated with problems in cattle rather than sheep. When sheep are introduced from known liver fluke areas, include a triclabendazole drench (which is effective against all stages of liver fluke) with quarantine treatments for worms.

The life cycle differs from the simple life cycle of roundworms, so control strategies are different.

Other worms

Gastro-intestinal parasites of minor importance such as large bowel worms and tapeworm are not covered.

Grazing management

Effective grazing management reduces the exposure of sheep to worms. There are three methods:

- Avoid paddocks heavily contaminated with worm larvae.
- Reduce contamination of paddocks with worm eggs.
- Allow time for most of the eggs and larvae on the pasture to die.

Which sheep are most susceptible to worms

Weaners and hoggets are the class of sheep most susceptible to worms, especially when they go through their second winter as hoggets. Paddocks used by young sheep in late autumn and winter should be of the highest quality pasture as the first priority, ideally, they should also be of low worm-risk. Pastures grazed after the autumn break (before the 'hogget winter') should be the lowest worm-risk on the farm. This will give hoggets a good start, in many cases allowing them to build immunity without suffering high initial worm burdens.

On winter hogget paddocks, most contamination occurs in late summer and autumn.

Lambing ewes are the next most susceptible group, as they temporarily lose some of their immunity to worms at and after lambing. As a result, they contribute to the seasonal increase in worm numbers and subsequent infection of lambs.

The following practices to prepare or choose low worm-risk paddocks are most important in the South-East and Higher Rainfall Mediterranean zones, but can also be used in the Lower Rainfall Mediterranean zone.

Preparing low worm-risk weaning and hogget paddocks

The following practices or a combination of these can create paddocks with less worm contamination and lower worm-risk:

- Rotational grazing with sheep
 - Compared to set-stocking, this typically involves creating a higher stocking rate with larger mobs (at least twice the set-stocking rate) and introducing them to the paddocks when the pasture is about 7 cm high and grazing down to 3 cm high. Aim to have a non-grazing rest period of at least 2 months in winter and 3 weeks during the active pasture growth phase.
- A non-sheep use in at least the 6–8 weeks prior to use with weaners or hoggets
 - Grazing paddocks with cattle
 - Cropping
 - Haymaking
 - New pasture establishment
- Grazing with adult sheep that have a tested low worm egg count (less than 50 epg)
- Grazing with sheep for up to 30 days after the protection period[®] of a drench proven effective on your property (¹1–2 days after short-acting drenches, weeks or months for persistent products), also see 'Smart grazing' on the WormBoss website.

Choosing lower worm-risk lambing paddocks

Choose the least contaminated lambing paddocks for the most susceptible lambing ewes (maidens, oldest ewes and earlier lambing ewes). Base this on results from *WormTests* from these paddocks over the last 6 months.

Breeding worm-resistant sheep

Genetic selection can be used to increase a sheep's resistance and resilience to worms. Resistance can result in fewer drenches being required each year and resilient sheep can better tolerate worms. The best way to increase the genetic resistance of your flock to worms is to use rams with better than average worm resistance. Currently, there are no commercially available tests to select for resilience.

What is the difference between resistance and resilience?

Resistance to worms

Sheep that are resistant to worms can prevent some or all worms from establishing and as a result have lower worm egg counts.

Resilience to worms

Sheep that are resilient to worms can grow and produce with less ill effects from worms. An animal's performance for a particular trait, such as growth, will also be dictated by its genetic merit for that trait. So, when comparing two animals with similar Australian Sheep Breeding Values (ASBVs) for growth, a more resilient animal will perform better than a less resilient animal when both have high worm burdens. It is independent of worm resistance so must be selected separately by choosing better production performance.

Drench resistance

Drench resistance is the ability of a worm to resist the effects of a drench. Note that drench resistance is a characteristic of the worm and differs from a sheep's resilience and resistance to worms.

Dag or Scouring

The propensity to scour has a substantial genetic component that is independent of both resistance and resilience to worms. To reduce dag/scouring select for low dag score and or low moisture levels in faeces independently to selection for low worm egg count.

How can a ram be selected for worm resistance?

1. Choose a stud that provides Australian Sheep Breeding Values for worm egg counts (WEC ASBV) and dag (DAG ASBV). Include selection against dag only where scouring is an issue.
 - Raw WEC values alone are not reliable enough to use in selection as they do not account for environmental differences or pedigree data (which are included in WEC ASBVs).
2. Ensure that selection for worm resistance and dag is balanced with other performance traits.
 - Select better than average WEC and DAG ASBV, i.e. choose the more negative values for both traits.
 - At the same time, select better than average ASBVs for performance traits that are important to you. A compromise regarding the various traits will be required.

Note: When extra traits are included in a selection program, the progress that can be made with each individual trait will decrease slightly, however progress with your breeding objective can still be high.

3. Choose the WEC ASBV age that corresponds to the time of most worm-challenge on your property, e.g. weaning (WWEC), post-weaning (PWEC), yearling (YWEC).

What are Australian Sheep Breeding Values?

ASBVs are an estimate of an animal's genetic merit rather than its visual or phenotypic merit. The effects of factors such as birth type, dam age, nutrition and management are removed to reveal an animal's genetic breeding value: what can be passed onto its progeny. ASBVs are calculated and reported by Sheep Genetics, the national genetic analysis service for the sheep industry. Ram breeders who are members of MERINOSELECT or LAMBPLAN will have WEC ASBVs available for their sheep if they are measuring WEC.

For more detailed information on using Australian Sheep Breeding Values, go to the Sheep Genetics website: www.sheepgenetics.org.au.

When to *WormTest* and when to drench

Why check worm burdens in sheep?

Checking worm burdens with a *WormTest* is essential for correct and timely drenching decisions. The result is healthy sheep without unnecessary drenching. *WormTests* are the best basis for drenching decisions. Weight loss, scouring, a tail in the mob and deaths may mean that your sheep need drenching. If so, these signs occur well after substantial production losses (reduced weight gain and wool growth) from worms have already occurred in the mob. *WormTests* give early warning before there are significant production losses.

How are worm burdens tested?

Checking worm burdens throughout the year using *WormTests* is a critical part of the WormBoss worm control program.

Most *WormTests* are done through a laboratory. However, worm egg counts (but usually not larval cultures) can be done by producers if they have the equipment and skills. Ideally, producers should have their preparation and counting technique reviewed by an accredited laboratory and perform ongoing quality control checks, just like an accredited laboratory to ensure their results are correct.

Which mobs and how many should have a *WormTest*?

In this South Australian winter rainfall region all mobs should be *WormTested* separately, rather than using one mob to represent another. Paddock differences here will have a significant effect on resulting worm burdens, even if the sheep are a similar class.

When should *WormTests* and drenches be routinely done?

Routine drench times

Note: Long-acting drenches are rarely required in South Australia. Unless professionally advised, use an effective short-acting drench when treating for worms. Where treatment for barber's pole worm is also required, broad-spectrum drenches are generally effective as drench resistance in barber's pole worm is as yet uncommon in South Australia. However, this may be changing in areas where sheep have been introduced from interstate, locations where barber's pole worm is more common.

South-East

- Lambs at weaning
- Working rams pre-joining
- The 'summer drench' (Late November/December, 2–3 weeks after the feed has dried, but before Christmas)

Higher Rainfall Mediterranean

- Lambs at weaning
- Working rams pre-joining
- There are no routine drenches for breeding ewes in this zone

Lower Rainfall Mediterranean

- Working rams pre-joining
- There are no other routine drenches in this zone

Routine *WormTest* times

WormTests can be done at any time; however there are certain routine times to *WormTest*, shown below. Use the results with the *Drench Decision Guide* to decide whether to drench and when other *WormTests* should be done.

A larval culture (larval differentiation) with the *WormTest* is particularly useful in areas or seasons in which summer rainfall occurs and barber's pole worm is a risk.

Note: Ram breeders should be aware that young rams under 2 years are highly susceptible to worms and should be regularly monitored as per weaners.

***WormTest* in the following situations:**

South-East

- Lambs kept on their mothers longer than 12–14 weeks (usually until turnoff)
Test at 12 weeks then each 4 weeks until turnoff
- Weaners
Test 4 weeks after the weaning drench then each 4–6 weeks until the end of their second (hogget) winter
- Ewes
 - Pre-lambing
 - Pre-marking
 - Pre-weaning
 - 6–8 weeks after marking if weaning is later than 14 weeks
 - 6–8 weeks after the 'summer drench', then 8 weekly till pre-lambing

Higher Rainfall Mediterranean

- Lambs kept on their mothers longer than 12–14 weeks (usually until turnoff)
Test at 12 weeks then each 4 weeks until turnoff
- Weaners
Test 4 weeks after the weaning drench then each 4–6 weeks until the end of their second (hogget) winter
- Ewes
 - Pre-lambing
 - Pre-marking
 - Pre-weaning
 - 6–8 weeks after marking if weaning is later than 14 weeks
 - 8-weekly from when the feed is drying until pre-lambing

Lower Rainfall Mediterranean

- Lambs at weaning
Many lamb mobs do not require drenching. Your options are:
 - Test prior to weaning by collecting only lamb dung (lamb dung is a smaller size—do not collect ewe dung as ewes can often have extremely low counts while lambs can have higher counts)
 - Test at weaning after lambs are separated: collect dung and keep lambs nearby until results are received
 - Or drench all lambs at weaning, but this is **not** the preferred option as many mobs will not need drenching
- Weaners
 - Test 6 weeks after the weaning drench
 - Thereafter, test at intervals depending on their feed quality: green pasture (6-weekly), dry pasture (8-weekly), on crop stubbles (10-weekly), until the end of their second (hogget) winter.

- Ewes
 - Pre-lambing
 - Weaning – test ewes if more than 10% are scouring
 - Just before harvest
 - 10 weeks after the pre-harvest test (if on pasture) or when ewes leave crop stubble

When are other *WormTests* done and drenches given?

The timing of *WormTests* and drenches will vary between farms and seasons. Use the *Drench Decision Guide* (see below) to weigh up important factors when deciding when to drench or *WormTest* on your property. These factors include signs of worms, time since last drench, *WormTest* results, time of the year, and condition of sheep and pastures.

If drenching is done for other reasons (such as an early drench before holidays or harvesting), use the *Drench Decision Guide* to decide when to drench or *WormTest* again.

Barber's pole worm in this region is usually sporadic and short-lived. If summer and/or autumn are unusually wet, check worm egg counts each 4–6 weeks through to early winter to identify unusual increases in barber's pole worms before they cause production loss and deaths. If worm egg counts exceed 1000 epg (or a little lower if sheep are in poor condition), drench with a short-acting drench effective against barber's pole worm or closantel (generally effective in this region). Test again in 4–5 weeks.

If your property faces a significant barber's pole worm risk for several months each year, seek professional advice regarding an effective program, which may include the Barbervax® vaccine.

What samples should be collected for *WormTests*?

Sheep do not need to be yarded for a *WormTest*. Collect warm fresh dung from the paddock (but make sure that ewe and lamb samples are not mixed).

To conduct a *WormTest* obtain sandwich bags (not ziplock) for individual animal samples and then follow the instructions provided by your testing laboratory or advisor. As a guide, collect 20 individual samples from mobs up to 400 sheep, and 20–40 samples from larger mobs. The laboratory will then 'bulk' these samples using an identical amount of dung from each sample.

Avoid delays in transit (when worm eggs can hatch) by collecting and posting early in the week. Also ensure samples are kept cool (refrigerate but do not freeze) before sending, include an ice brick in transit in very hot weather and exclude as much air from the sample bags as possible.

If you do your own worm egg counts, a 'bulk' test is easier than counting individual samples. Fewer bags or trays are needed and more sheep in the mob can be sampled.

The following fact sheet is on the WormBoss website: www.wormboss.com.au: 'Checking a mob of sheep for worms with a *WormTest*'.

The WormBoss Drench Decision Guide

The *Drench Decision Guide* helps to simplify decisions on whether and when to drench. There is a version of the *Drench Decision Guide* for each WormBoss region.

It considers

- whether signs of worms are present
- the class of sheep
- the *WormTest* results
- the condition of the sheep
- the condition of the pasture
- the likely worm contamination of the paddock

The *Drench Decision Guide* will recommend

- whether to drench now
- whether to use a persistent drench
- when to *WormTest* again

How to use the Drench Decision Guide

You can use the *Drench Decision Guide* at any time, whether you are contemplating drenching a mob now or in coming weeks. Not all situations require a *WormTest*: the *Drench Decision Guide* will recommend when these should be done.

1. Firstly, refer to the *Drench Decision Guide*, which is provided separately.
2. Start on the page that shows the '*Drench Decision Guide Questions*'.
3. Read Question 1.
4. Follow the 'go to' information on the right for the answer that applies to your mob.
5. Only go to the question or recommendation to which you are directed by your answer.
6. When you are directed to a letter, this is the final recommendation, and is shown on the next '*Recommendations*' page.
7. Also read the important information in the green boxes.

The *Drench Decision Guide* is also available on the WormBoss web site (www.wormboss.com.au) where it is presented differently, so that you only see the questions and a recommendation relevant to your answers.

Managing drench resistance

Why manage drench resistance?

To stay profitable in the long-term, you will need to prolong the effective lives of old and new drench groups by using them well. (Drench groups are the 'chemical families' of drenches. Older groups can often be combined with newer groups to slow development of resistance).

Selection for drench resistance happens when worms in a sheep are exposed to a drench. Some worms can survive certain drench actives as they have genes for drench resistance. This may initially be just one worm in 100,000 or even 1,000,000 worms. Some worms present may be partly drench-resistant: they can survive lower (sub-lethal), but not full doses of the treatment.

Worms that survive treatment continue to produce eggs that give rise to infective larvae on a pasture. These are eaten by sheep and so the worm life cycle continues. In this way each treatment causes an increase in the proportion of the worm population that is either partly or fully drench-resistant.

If resistance to a drench active is already present, it will likely remain, even if the drench group is not used for years. Drench resistance probably cannot be prevented, but the rate at which it occurs can be greatly reduced.

The first step is to know what drenches are effective on your property.

How can the effectiveness of drenches be tested?

Each property has its own drench-resistance profile based on its own drenching history and that of properties from which sheep are sourced. The profile of neighbouring properties can be quite different.

The extent of resistance is only known by testing. Obvious worm control failures may only occur when resistance is quite advanced.

A *DrenchTest* is needed to accurately test for drench resistance. Do these tests every 2–3 years. Test all single-actives that are likely to be used as part of multi-active (combinations) products on your farm.

A *DrenchCheck-Day10* is used to check individual drenches at any time. Regularly do *DrenchCheck-Day10s* between the times that full resistance tests (*DrenchTests*) are performed.

The *DrenchTest* (WECRT)

DrenchTest is the common name for the Worm Egg Count Reduction Test (WECRT). This assesses the drench-resistance status of worms on a property.

You can test as many individual or combination drenches as you like in a *DrenchTest*.

Select a mob for the *DrenchTest*. From this mob, a group of sheep is used for each drench and one group of sheep is left undrenched to act as a 'control' or comparison. Each of the groups is drenched (except the control group) and dung samples are collected from all of the sheep 10–14 days after the drench, for a *WormTest*.

The worm egg counts of each treatment group are compared with those of the undrenched control group. From this, the effectiveness of each drench against each worm type present is calculated.

Discuss the test with your adviser before setting up. For more detail see the fact sheet 'Testing drench effectiveness with a *DrenchTest*' on the WormBoss website (www.wormboss.com.au).

The *DrenchCheck-Day10*

This simple and inexpensive test gives an indication of drench effectiveness and whether it should be properly investigated using a *DrenchTest*.

The *DrenchCheck-Day10* involves two *WormTests*: the first up to 10 days before drenching (usually at a routine *WormTest* time) and the second between 10 and 14 days after the drench. Samples from individual dung piles (10–20) are used for this test, not a bulk collection.

The results from the two *WormTests* are compared to gauge the extent that worm egg counts have been reduced by the drench. Discuss the results with a worm control advisor.

For more detail see the fact sheet 'Checking for drench resistance with a *DrenchCheck-Day10*' on the WormBoss website (www.wormboss.com.au).

How can drench-resistant worms be kept out of your property?

Keeping drench-resistant worms out of your property is part of sustainable worm control.

Assume that purchased sheep are carrying worms with some degree of drench resistance to one or more drench groups (see [Appendix 3: Drench groups and actives](#)).

1. 'Quarantine' drench all sheep new to the property.
 - Use a combination of no less than 4 unrelated drench actives with at least one of these being monepantel (Zolvix®) or derquantel (with abamectin—Startect®). This can be done using multi-active (combination) and/or single-active products concurrently—up the race with one product, then up the race again with the next.
 - Do not mix different drenches unless the label states you can or under veterinary advice, as different products may be incompatible.
2. Quarantine the sheep after treatment.
 - Hold the sheep in quarantine in yards (small mobs) or a secure paddock (larger mobs) for at least 3 days to allow worm eggs present at the time of drenching to pass out of the gut.
 - Provide adequate feed and water.
 - Keep this paddock free of sheep, goats or alpacas for at least 3 months in summer or 6 months in cooler months.
3. After quarantine, release the sheep onto a paddock that is likely to be contaminated with worm larvae due to grazing by other sheep. This would include most paddocks that have been grazed by home bred sheep for the last 3 months. This will 'dilute' (lower the proportion of) resistant worms surviving treatment with worm larvae already on your property.
4. *WormTest* the imported sheep 10–14 days after drenching for added confidence that treatment was successful.
5. Get expert advice on up-to-date recommendations for quarantine treatments (especially if step 3 cannot be achieved). These will evolve as the drench resistance picture changes.

How can the development of drench resistance be slowed?

Choosing drenches

Integrate all 4 principles where possible:

1. *Use a fully effective drench or combination of drenches for the strategic (summer) drenches:* A fully effective drench is one that reduces the worm egg count in your sheep by at least 98% as shown by a *DrenchTest*. The more effective a drench is, the fewer drench-resistant worms will remain in the sheep after treatment. Note: Drenches of less effectiveness (say 90–95%) may still be sufficient if sheep are treated in winter and returned to contaminated pastures (e.g. a pre-lambing drench, however, these drenches or combinations should not be used as a summer drench.)
2. *Use a combination of two or more actives where possible;* fewer worms are able to resist more than one active at a time, but these combinations must be tested in your flock.
3. *Use short-acting treatments where possible,* and restrict the use of persistent products for specific purposes and high worm-risk times of year. See later section, 'How can persistent treatments be used effectively?' There is little need to use mid-length or long-acting treatments if sheep are being moved to low worm-risk (Smart-grazed) paddocks.
4. *Rotate* among all effective drench groups each time a mob is drenched (and for each paddock where possible).* An effective drench from a different group may kill worms that were resistant to the last treatment. These may be worms that survived treatment in the sheep or were picked up from the paddock.

*When rotating drenches the current drench ideally would include no actives that were used the previous time. However, in practice, try to ensure it has at least one effective active from a drench group that was not used the previous time.

Using drenches

Follow all 5 principles where possible:

1. *Avoid unnecessary drenching* by using *WormTests* to guide drench decisions, especially
 - a. adults
 - b. during droughts or prolonged dry periods
 - c. immediately before or after moving sheep onto very clean, low worm-risk paddocks (such as ungrazed cereal stubbles or paddocks that have been sheep-free for extended periods). See points i) and ii) below for further discussion on this.
2. *Calibrate drench guns* to ensure the correct dose is delivered.
3. *Calculate the dose based on the heaviest animals in the mob*. Split mobs for drenching if there is a large weight range, so sheep are not under-dosed.
4. *Follow the label instructions* to ensure correct dose and use of treatments.
5. *Except for weaners (and when preparing low worm-risk paddocks with 'Smart grazing'), don't move newly-drenched sheep into low worm-risk paddocks.*

When the weaners finally leave their prepared paddock:

- i. Give them an effective drench of a different group to that used when they entered the paddock.
- ii. The next mob to use the paddock should not have been drenched recently, and their most recent drench should be a different drench group to what the weaners had when they entered the paddock.

How can persistent treatments be used effectively?

Persistent or long-acting treatments are rarely required in South Australia. Only use them if professionally advised to do so.

Effective persistent treatments kill immature and adult worms in the sheep at the time of treatment, as well as infective larvae eaten by sheep (with pasture) during the period of protection of the treatment—about 3 months for long-acting and 1–4 weeks for mid-length treatments (depending on the particular product).

Persistent treatments may increase selection for resistance to the actives in those treatments for two reasons. Firstly, worms are exposed to the active for longer. This favours surviving resistant worms, which then reproduce in the absence of susceptible ones. Secondly, persistent treatments have a longer time at the end of their protection period where the active concentration has dropped to a level where partially resistant worms may establish in the sheep, survive and start reproducing.

Persistent drenches appear to pose a particular risk for selection for resistant Barber's Pole Worm (*Haemonchus*). However, the situation is less clear for scour worms, which reproduce more slowly, and the interactions between using persistent products and selection for resistance are quite complex and incompletely understood.

Using primer and exit drenches with long-acting treatments

Primer drenches clear the sheep of any worms at the commencement of the long acting treatment that are resistant to the long-acting treatment. A primer drench is an effective short-acting drench (preferably a combination) that does not include the same group as the long-acting product. It is given at the same time that a long-acting product is given. A primer does not stop sheep accumulating resistant worms during the protection period of the long-acting treatment.

Exit drenches are used two weeks after the end of the actual protection period. By this time, the persistent treatment has declined to very low levels in the sheep. The exit drench kills larvae that have survived the persistent treatment and developed into breeding adult worms. Another name for the exit drench is a 'tail cutter'.

An exit drench (like the primer drench) is an effective short-acting treatment (preferably a combination) that is from a different group/s to the persistent product.

The need for either treatment in this region will be dictated by the results of a drench resistance test and monitoring of worm egg counts during the period the long-acting treatment should be effective. *WormTests* at monthly intervals (30, 60 and 90 days) after a long-acting treatment are ideal. However, a primer drench should routinely be used with all capsules

Check the persistence of a product

The effectiveness of the persistent product on your property will be shown by the length of the protection period actually achieved (rather than what is claimed on the product label). Persistent products that you plan to use should also be tested in a *DrenchTest* each 2–3 years. However, if you do not have current *DrenchTest* results and you plan to use a persistent product before your next scheduled *DrenchTest*, you should do a *DrenchCheck-Day10* (see page 11) after the next treatment. Also, conduct a similar test (collecting 20 individual samples rather than a bulk sample) at 60 days and 90 days after it is given to establish how long it is effective. If it is shown to be ineffective at one of the earlier tests, then the later test/s will be of no value.

When you send the samples, request a larval culture if there is a positive worm egg count because

- resistance may only be present in one worm species
- if moxidectin was used, the protection period against different worm species differs
- if closantel is used, it is a narrow spectrum drench only for barber's pole worm

If the treatment was fully effective, and you used a primer and exit drench, the product will probably have a similar length of effectiveness at the next use. However, it is best to check the effectiveness of long-acting products every year they are used by doing a *WormTest* at 60 days for a capsule (for moxidectin, where efficacy varies against worm species, *WormTest* at 35 days if scour worms are your prime consideration or 60 days in high-risk barber's pole worm areas). For these tests collect 20 individual samples rather than a bulk sample.

If a *WormTest* shows worm eggs are present before the end of the claimed protection period, drench resistance is likely. You should:

1. Immediately drench the sheep with an exit drench (as described earlier), keep them in their current paddock for a further 3–4 days (while most eggs pass in the dung), then move them to another paddock. This will stop more drench-resistant worm eggs from contaminating the pasture.
2. The next sheep to graze this paddock should have a moderate to high worm burden, with their last treatment not being from the same drench group as the long-acting product. This will help to dilute the resistant-worm eggs already on the pasture.
3. Seek professional advice on further use of products from this drench group and how they should be checked.

At any time that you are concerned that a mid-length or long-acting treatment is not providing protection, *WormTest* immediately and seek professional advice regarding drench resistance.

Appendix 1: Roundworm life cycle and larval availability

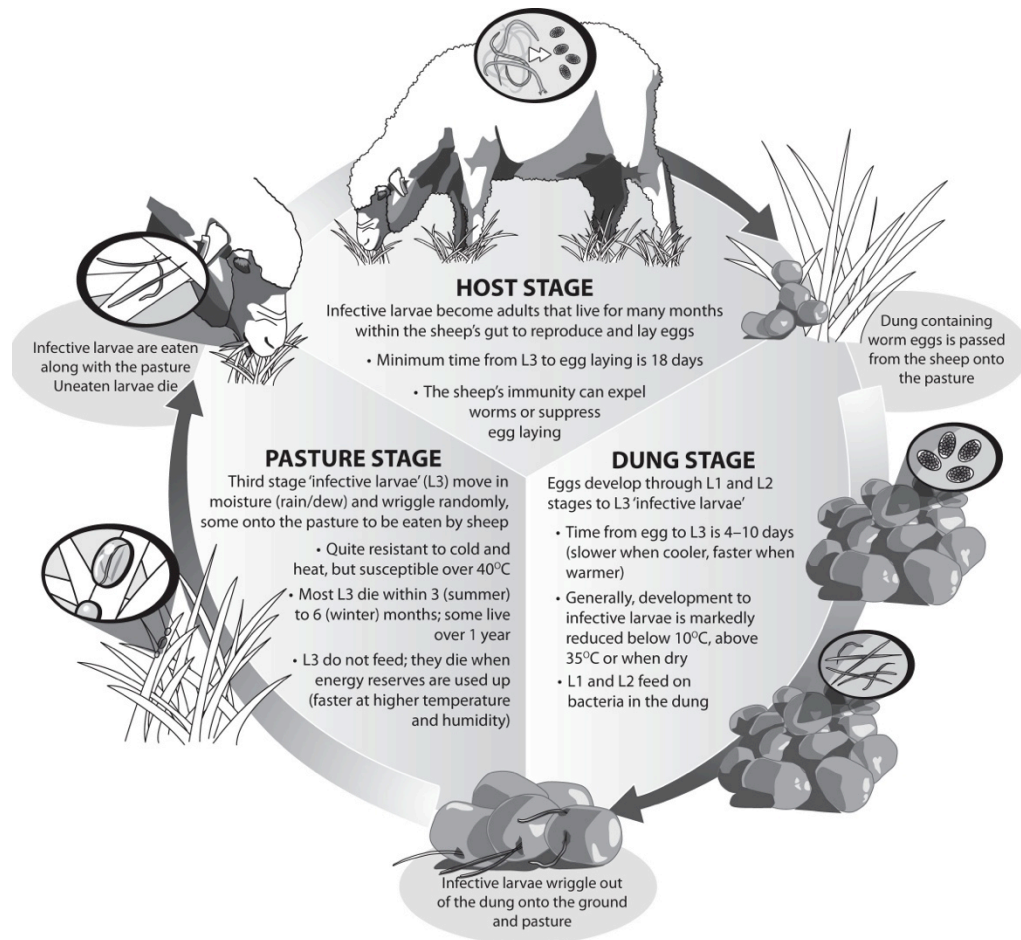
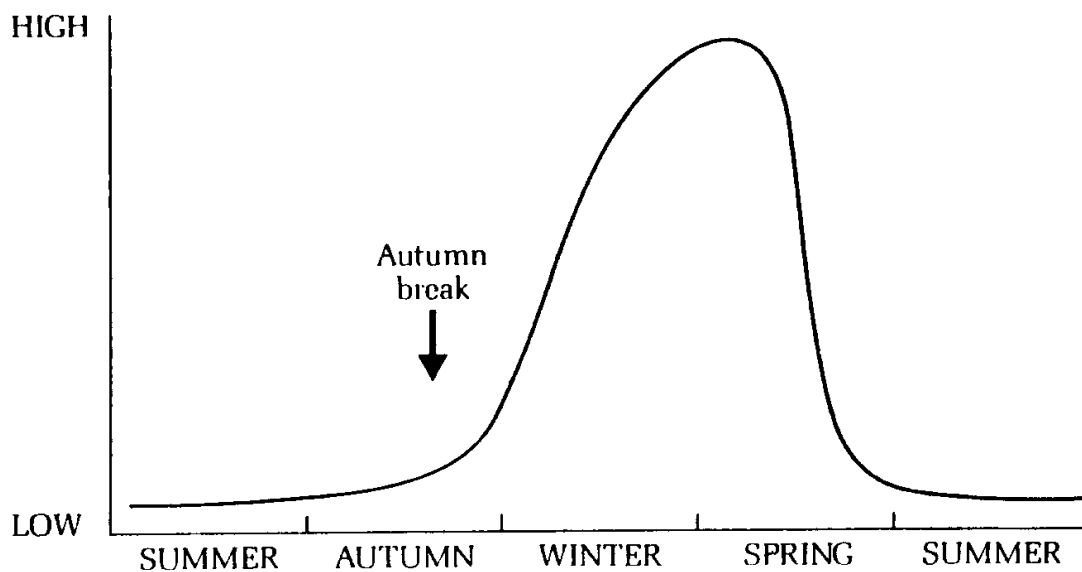


Figure 1. The life cycle of sheep roundworms



Source: The epidemiology and control of gastrointestinal parasites of sheep in Australia. Edited by A.D. Donald, W.H Southcott and J.K. Dineen, Division of Animal Health, CSIRO 1978.

Figure 2. The availability of infective larvae of the winter scour worms on pasture, showing a peak around June–August (depending upon the timing of the autumn break)

Appendix 2: Drench groups and actives

Drench groups and actives	Worms	Examples* of brand names/comments
BZ or benzimidazole group ('white') ^B albendazole fenbendazole oxfendazole	barber's pole worm, 'scour worms', adult liver fluke, nodule worm, aids control of intestinal tapeworm (<i>Moniezia</i>)	Valbazen (albendazole) WSD Fenbendazole (fenbendazole) Oxfen (oxfendazole)
LV or levamisole group ('clear') ^B levamisole	barber's pole worm, 'scour worms', nodule worm	Nilverm, Levamisole Gold
ML or macrocyclic lactone group ^B (sometimes called 'mectins') Ivermectin abamectin moxidectin	barber's pole worm, 'scour worms', nodule worm	Ivomec, Noromectin (ivermectin) Absolute, Vetmec, Paramectin (abamectin) Cydectin (moxidectin)
AD or amino-acetonitrile derivative group ^B monepantel	barber's pole worm, 'scour worms'	Zolvix
SI or spiroindole group ^M derquantel	barber's pole worm, 'scour worms', nodule worm	Derquantel is only found in a combination: Startect (abamectin + derquantel) ^B
OP or organophosphate group ^M naphthalophos (NAP) (OPs have lower or variable efficacy against 'scour worms' in the upper GIT and immature barber's pole worm)	barber's pole worm, 'scour worms'	Rametin (naphthalophos is commonly used in combinations)
TZ or benzimidazole group (flukicide) ^N triclabendazole	Liver fluke (all stages); not effective against round worms	Tremacide
SA or salicylanilides/phenols group ^N closantel oxyclozanide	Liver fluke (> 9 weeks and adult) and barber's pole worm Liver fluke (adults) and tapeworm	Closicare (closantel) Oxyclozanide is only found in a combination: Nilzan (levamisole + oxyclozanide) ^B
IQ or isoquinolone group ^N praziquantel	Intestinal tapeworm (<i>Moniezia</i>)	Praziquantel ^N is only available in combination with broad-spectrum drenches. First Drench ^B , Genesis Tape ^B

*ParaBoss does not endorse specific brands, these are presented here as examples only.

Breadth of activity across different worm species: ^BBroad-spectrum; ^MMid-spectrum; ^NNarrow-spectrum

Actives: An 'active' is the chemical in a drench responsible for killing worms. Some drenches have more than one active and are called 'multi-active' or 'combination' drenches.

Combination or multi-active treatments: Proprietary treatments containing more than one active. Formulated to be compatible as a mixture. Note: Do not mix your own drenches unless the labels state that you can.

Product formulation: All single actives are available as oral drenches. Moxidectin is also available in injectable products. Intra-ruminal/controlled release capsules are available with BZ and/or ML actives. Abamectin is also in a pour-on formulation for both lice and worm control.

Length of protection: Varies from short-acting ('knock-down' that kills susceptible worms within the animal) to mid-length (1–4 weeks) and long-acting (approx. 3 months), which not only kill susceptible worms already in the animals, but also susceptible infective larvae that the sheep eat during the protection period.

'Scour worms': Mainly black scour worm and (small) brown stomach worm, but also others.

Label: Check product labels for full details. Follow the label.

Other parasites: 'Drenches' in www.wormboss.com.au shows effectiveness of groups against other parasites of minor importance.

wormboss

The WormBoss website is the most complete and current source of information for producers, advisors and students on sheep worms, drenches and worm control in Australia.

On the site you will find information and tools:

Regional worm control plans

A step-by-step guide to controlling worms practically, effectively and profitably on your property all year round.

Regional Drench Decision Guides

A tool to help you decide whether your sheep need drenching now, and if so, what length of protection is required and when to check the sheep again.

Drenches

Lists all of the drench groups and combinations as well as actives and brand names.

Tests and tools

'How to' guides are provided on WormTests, DrenchTests and more.

Worms

Describes the important worm species, their lifecycle and how they affect sheep.

Subscription

Subscribe to the ParaBoss monthly e-newsletter to keep up to date on your regional worm situation and new information.



wormboss.com.au