



WORM CONTROL PROGRAM

Western Australia winter rainfall

A regional worm control program from WormBoss





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WormBoss worm control program

Western Australian winter rainfall

Program summary

The WormBoss worm control program for the Western 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 a strategic drenching¹ program (see descriptions of zones on next page)

- *The South-West Medium to High Rainfall Zone*
 - Lambs at weaning.
 - Weaners in early summer, after the pasture has dried off.
 - Hoggets (last year's lambs) in early summer, as for the weaners.
 - Adult sheep in autumn, between the end of March and the end of April.
 - Late-lambing ewes (later than mid-June) pre-lambing, and where a *WormTest* is not conducted.
- *Low Rainfall Cereal Zone*
 - Lambs at weaning or as lambs are moved onto a crop stubble if this is within a few weeks of weaning.
 - Hoggets (last year's lambs) in early summer, unless *WormTests* over some years indicates there is rarely a need.
- Drench all introduced sheep with a combination of no less than 4 unrelated drench groups with at least one of these containing the newest drench actives: monepantel (Zolvix[®]) or derquantel (with abamectin—Startect[®])².
- At other times, use the *Drench Decision Guide* and *WormTest* results to make drenching decisions.

2. *WormTest* at recommended times (see descriptions of zones on next page)

- *The South-West Medium to High Rainfall Zone*
 - Weaners, 4–6 weeks after their weaning drench, unless a summer drench is to be given about that time.
 - Hoggets (last year's lambs).
 - 6 weeks after the season's break, or by the end of June at latest, then 6-weekly until the end of spring
 - 6 weekly after any drench is given in winter or spring (unless a drench is to be given at about that time).
 - Late-lambing ewes (mid-June onwards) *WormTest* 3 weeks before lambing is due to commence.
- *Low Rainfall Cereal Zone*
 - Adult sheep in late March to April.
- **And at other non-routine times as described in the *Drench Decision Guide*.**

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

- Prepare winter/spring low worm-risk paddocks for lambing ewes, weaners and hoggets by preventing contamination with worm larvae in the 3 to 4 months before they are needed:
 - Spell paddocks, graze with cattle, use for crops, hay or new pastures.
 - Or (not in coastal areas) graze with sheep that have a tested low worm egg count (less than 200 epg).
- Choose the least contaminated lambing paddocks for the most susceptible lambing ewes (maidens, twin-bearing, or poorer condition).

4. Breed and feed for worm-resistant sheep

- Use rams with better than average WEC and DAG ASBVs³ (choose the more negative values).
- Maintain good nutrition to enhance the sheep's immunity to worms.

5. Manage drench resistance

- Avoid summer drenches to adult sheep (instead, drench in autumn).
- Conduct *DrenchTests* each 2–3 years and use *DrenchCheck-Day10s* in between.
- Avoid unnecessary drenching.
- Use effective drenches only, and multi-active² combinations where possible (those shown to be highly effective on your property).
- Restrict the use of long-acting products to high worm-risk periods, and seek expert advice on their use.
- Rotate among all effective drench groups² for each mob (and each paddock where possible).
- Calibrate your drench guns, dose to the heaviest sheep and follow label instructions.

¹ Drench refers to worm treatments regardless of route of administration. ² 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 3: Drench groups and actives](#). ³ ASBVs=Australian Sheep Breeding Values.

This is an up-to-date, integrated regional worm control program for sheep in the south-west region of Western Australia. It builds upon earlier programs and accumulated knowledge, including from the Department of Agriculture and Food, the experience of researchers, consultants and advisers, and new information from the 'Integrated Parasite Management in Sheep' project (funded by Australian Wool Innovation).

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

- fewer deaths and illness from worms
- less drenching
- improved productivity
- prolonged life of drenches

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

Where is the Western Australian winter rainfall region?

In Western Australia, there are two main 'worm control' zones within the winter rainfall region. Both have a typical Mediterranean-type climate, defined by hot, dry summers and cool, wet winters. The major difference between the zones is in regard to the amount and duration of winter rainfall, and the boundaries for these zones are only approximate as seasonal temperatures and rainfall variations affect worm development.

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

The South-West Medium to High Rainfall Zone

This includes the corner of the state, south-west of the 350 mm rainfall isohyet. It starts at the coast a little north of Kalbarri, continues west of Mullewa and Perenjori, then includes Cadoux, Quairading, Corrigin, Lake Grace, Ravensthorpe, and Esperance near its eastern or northern edge.

Sheep are a more important part of the farming enterprise than in districts to the east, and both the total rainfall and seasonal duration (months of rainfall) is greater in this zone. Conditions for worm burden development are therefore more favourable than in drier areas.

There is a large variation between districts in this zone in the annual risk of significant worm problems due to rainfall differences, although the basic control plan is applicable. The worm risk is lower east of the 500 mm isohyet, where there is usually a shorter pasture growth season and a greater area of the farm is under crop.

Closer to the coast within the zone the rainfall is considerably higher, and pastures often retain a green component over summer (a barber's pole worm risk). Along the south coast and west of Bremer Bay, and in a coastal zone along the west coast as far as Geraldton, the rainfall is both greater and of longer seasonal duration, further increasing the likelihood and duration of the worm risk.

The Low Rainfall Cereal Zone

This zone is east of the 350 mm isohyet, extending to the border of the Pastoral Zone of the state and includes Mullewa, Wubin, Bullfinch, Southern Cross, Merredin, Hyden and Lake King. In these areas the summers are hot and the effective rainfall is relatively low. As cropping is the dominant enterprise, the large areas of crop stubbles provide significant opportunities to avoid worm intake. The worm risk is therefore low in most years, and especially in eastern areas of the zone, visible signs of worms are only occasionally seen after unusually heavy summer rainfall.

What worms are covered in this program?

Roundworms

The most important roundworms in this region are:

- Scour worms
 - Small brown stomach worm *Teladorsagia (Ostertagia) circumcincta*
 - Black scour worm *Trichostrongylus vitrinus*
Trichostrongylus colubriformis
 - Thin-necked intestinal worm *Nematodirus spp*

In areas where sufficient summer rainfall occurs to maintain perennial pastures (mostly within 40 km of the coast):

- Barber's pole worm *Haemonchus contortus*

Higher burdens of all worms are likely in very wet years. These can be fatal with or 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.

Other worms

Gastro-intestinal parasites of minor importance such as tapeworms are not covered. Liver fluke does not occur in Western Australia.

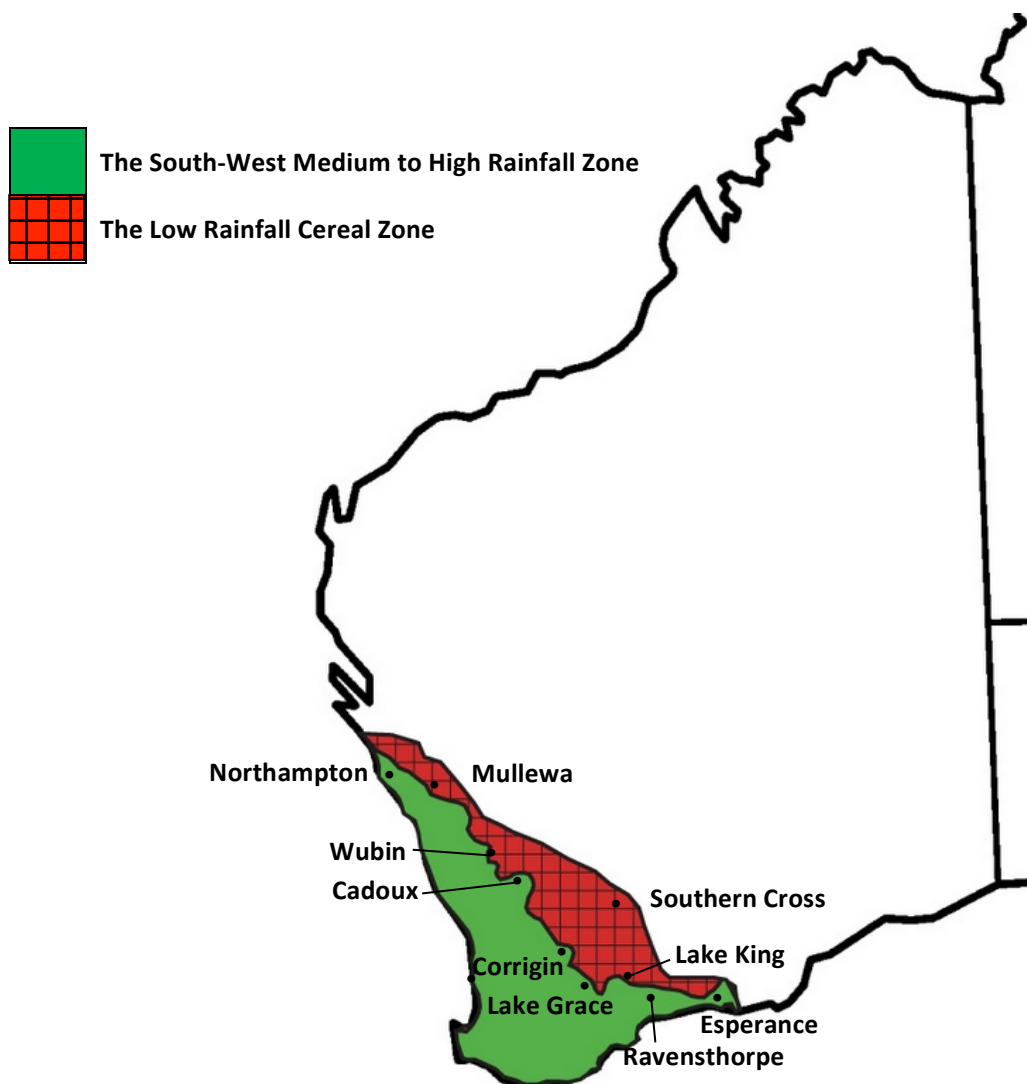


Figure 1. The Western Australian winter rainfall region

Grazing management

Effective grazing management (pasture planning) reduces the exposure of sheep to worms, and hence the likelihood of worm disease or significant production loss. There are three methods for minimising the worm risk of pastures:

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

There is a **risk** that drenching sheep onto low-worm pastures may increase drench resistance levels in the same way that summer drenching does (see page 7).

Which sheep are most susceptible to worms?

- Lambs in the months after weaning, before they develop a significant level of worm immunity. However, lambs do need to take in some worm larvae to develop their immunity; this occurs while sheep are on green pasture. Later-drop lambs (July and later) and lambs kept on low-worm pastures take longer to develop an immunity to worms than earlier-born lambs.
- Hoggets are also relatively worm-susceptible, especially if late-born.
- Lambing ewes are susceptible to worms as their worm immunity is temporarily reduced for several weeks from the time of lambing. This can contribute to the seasonal increase in worm numbers and later infection of lambs. A particular risk is for autumn-lambing ewes in barber's pole worm areas.

The following practices to prepare or choose low worm-risk paddocks are most important in the South-West Medium to High Rainfall zone, especially in areas of higher rainfall where worm problems are common.

Preparing low worm-risk paddocks

The main need for low-worm pastures in WA is in winter and spring for weaners and lambing ewes, as in summer the hot, dry conditions prevent larval survival, and pasture growth is generally not sufficient to support significant larval development until May or later.

In the 3–4 months during autumn to winter, before you want to use a low worm-risk paddock, prevent contamination with sheep worm eggs by:

- spelling these paddocks from sheep (graze with cattle or use for crops, hay or new pasture establishment).
- or (not in coastal areas where barber's pole worm is a concern) graze with sheep that have a tested low worm egg count (less than 200 epg).

Spelling for 3–4 months in spring or autumn results in about 90% or more worm larvae dying. Less than two months is not enough for a low worm-risk pasture; four months is only required if spelling includes winter months, when larvae take longer to die.

Avoid grazing the most susceptible sheep in the highest worm-risk paddocks

Where possible, avoid grazing weaners and lambing ewes (especially maidens, twin-bearing ewes or those in poorer condition) in high worm-risk paddocks. Paddocks most likely to carry significant numbers of worm larvae in winter or spring include those grazed by:

- Wormy sheep: where worm problems have occurred, or sheep have significant worm egg counts, sheep not given summer or autumn drenches, or where ineffective products have been used (this will rarely be visible in terms of signs of worms).
- Young sheep (two years or less of age). These are likely to have higher counts than older animals, but whether they have a significant count at a particular time can only be shown by a worm egg count.

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.
 - WEC values on individual sheep 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, 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 drench and when to *WormTest*

Annual drenching programs ('Summer-autumn drenching')

The strongly seasonal nature of Mediterranean environments lends itself to a routine drenching program, as dry summer and autumn pastures are unfavourable for worms, and sheep drenched then do not pick up new worm burdens. This is the basis of the highly efficient 'summer drenching' program. However, summer drenching has been confirmed as the main factor causing the high levels of drench resistance in WA, as any worms surviving these drenches (i.e. resistant worms) are the source of future worm populations.

To reduce the risk of drench-resistance without affecting the effectiveness of worm control, 'summer drenching' should be replaced by '**Summer-autumn drenching**'. (See DAFWA FarmNote No. 348: 'Sheep worms — a change to summer autumn worm control' at www.agric.wa.gov, then Animal Health, then Parasites.)

Under this program, drenches for adult sheep are delayed until autumn, and only weaner and hogget-age sheep are drenched in summer. Most adult sheep have low worm egg counts in early summer and a drench at that time is not warranted; delaying a drench until late March or April allows some less-resistant worms to survive. Provided that the worm population on the property includes sufficient less-resistant worms to dilute resistant worms, the overall resistance level on the property will be reduced.

Why check worm burdens in sheep?

Checking worm burdens with a worm egg count (*WormTest*) indicates whether worm control is on track (no significant effect on sheep) or whether treatment is needed. Worm egg counts are important in several situations:

- To confirm whether signs of ill-health are likely to be due to worms. Many signs are not specific to worms, e.g. weight loss and poor growth rates, a tail in the mob, scouring and possibly deaths.
- To check whether moderate worm burdens are causing production loss, even though signs of worms are not present. Reduced weight gains and wool growth occur well before signs of ill-health are seen.
- To show whether the number of worm eggs being passed onto pasture is too high for a particular time of year. The level of pasture contamination with worm larvae in autumn largely determines the extent of worm problems in winter and spring.

How are worm burdens tested?

Checking worm egg count using *WormTests* is a critical part of the WormBoss worm control program.

WormTests are mostly done by private veterinarians or DAFWA laboratories. In addition, many farmers have done DAFWA worm egg count courses and carry out tests on their own flocks. Some local worm egg counting service providers are also operating—it is important to seek professional advice where worm egg count results are not simple to interpret.

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

It is best to test each mob individually as it is difficult to extrapolate worm egg count results from one mob to another, even of the same age or class. There are usually differences between paddocks in the favourability for worm survival, the number of worm eggs being deposited by different mobs, and the time since a drench was given. In some cases, a drench may be given to some mobs but others *WormTested*.

When should *WormTests* and drenches be routinely done?

Routine drench times

In WA, the routine 'Summer-autumn drench' program is recommended for the main sheep areas (the South-West Medium to High Rainfall Zone). In the Low Rainfall Cereal Zone, routine treatment is needed only for younger age classes. It is critical that all drenches given in summer and autumn are given with a fully-effective drench, as otherwise drench resistance is likely to increase more rapidly.

The South-West Medium to High Rainfall Zone

- Lambs at weaning
- Weaners in early summer, after the pasture has dried off (this can often be done as the lambs go into a crop stubble paddock)

Note: If weaning occurs when the lambs are on dry pasture or are to be placed onto a crop stubble, the weaning and summer drench coincide and only a single drench is needed.

- Hoggets (last year's lambs, including maiden ewes) in early summer, as for the weaners.
- Adult sheep in autumn, between the end of March and the end of April
Worm burdens in sheep of this age rarely justify a summer drench, but this can be easily checked with a *WormTest* (especially maiden ewes) if you are concerned.
- Late-lambing ewes (lambing later than mid-June) pre-lambing if a *WormTest* is not conducted (see Routine *WormTest* times, below). In early-lambing ewes, the March-April drench removes the need for a specific pre-lamb treatment.
- In barber's pole worm areas, a long-acting drench should be considered for ewes lambing in May or June.

Low Rainfall Cereal Zone

- Lambs at weaning or as lambs are moved onto a crop stubble if this is within a few weeks of weaning.
- Hoggets (last year's lambs) in early summer, unless *WormTests* over some years indicates there is rarely a need.

Routine *WormTest* times

Routine *WormTesting* is recommended mostly in the months when sheep are grazing green pasture, as worm eggs and larvae require moisture to develop. For opportunities to fine-tune programs with *WormTests*, see the section below: 'When are other *WormTests* done and drenches given'.

The South-West Medium to High Rainfall Zone

- Weaners, 6 weeks after their weaning drench, unless a summer drench is to be given at about that time
- Hoggets (last year's lambs)
 - 6 weeks after the season's break, or by the end of June at latest then 6 weekly to the end of spring
 - 6 weekly after any drench is given in winter or spring (unless a drench is to be given at about that time)
- Late-lambing ewes (lambing later than mid-June) *WormTest* 3 weeks before lambing is due to start.

Low Rainfall Cereal Zone

- Adult sheep in late March to April
Check whether a drench is necessary (testing for a couple of years will indicate the need for a routine drench).

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.

Worm control can be made more efficient using *WormTests* over a couple of years to determine whether a routine drench or a *WormTest* will usually be appropriate at a particular time of year. Examples are:

- Ewes in early summer and mid-autumn in the Medium-High Rainfall Zone: where a summer drench is not justified, but an autumn drench is usually needed. There may be variations to this pattern.
- Pre-lambing drenches for ewes: often given routinely, but in fact are not always necessary.
- Drenches to hoggets in the Low Rainfall Zone: in drier areas, these may not be warranted.

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. 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.

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. Some groups can be combined with others 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 'groups' 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 group 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 and test all drench groups.

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.

WormBoss recommends testing actives from all drench groups; from these results, resistance to the multi-active products can be calculated.

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 details, including which drenches to test, 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 groups 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 a day to allow worm eggs present at the time of drenching to pass out of the gut.
 - Provide adequate feed and water.
 - If feasible, 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?

Timing of drenches

The drenching programs outlined above aim to provide good worm control with the minimum increase in drench resistance. This includes both keeping drench usage to the minimum necessary and ensuring that some non-resistant worms remain somewhere in the worm population on the property, so they can dilute resistant worms that survive a drench. (This is known as the 'refugia' principle, that is, ensuring some non-resistant worms are in refuge from drenches.)

In Western Australia, the long, hot, dry summer causes worm eggs on the pasture to die, with only the worms in the sheep surviving to the next year. While young sheep should receive a summer drench, the resistant worms inside the sheep at the drench time will be the only survivors over summer. From autumn, successful development of their eggs to larvae will resume, increasing the number of resistant worms on the farm.

To counteract this, it is recommended that adult sheep do not receive a summer drench; instead they are drenched in autumn. In this way, they carry the less resistant population of worms inside them over summer. From early March onwards, before they receive their autumn drench, some of the eggs from these worms can develop to the larval stage, providing a population with more susceptible worms compared to those carried by sheep that received a summer drench.

Move the summer-drenched sheep onto the pastures contaminated by the adult sheep so that the resistant worm eggs the summer-drenched sheep leave are diluted among the less-resistant worm eggs left by the adult sheep. This will reduce the overall proportion of resistant worms on the farm.

Ironically, drenching sheep onto 'worm-safe' pastures at any time of year can have the similar effect of promoting drench resistance—while recommended for highly worm-susceptible sheep (especially weaners), some caution is needed for use of 'worm-safe' pastures as a routine.

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 drench groups where possible;* fewer worms are able to resist more than one group 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 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 groups 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 4 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).
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 excessively over-dosed.
4. *Follow the label instructions* to ensure correct dose and use of treatments (including complying with withholding periods).

How can persistent treatments be used effectively?

Persistent or long-acting treatments are rarely required in Western 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; also, larvae from resistant worms will become adult worms when non-

resistant ones are killed. Secondly, some 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 products may be recommended where there is a severe worm risk that cannot be managed otherwise. However, worm control of a level similar to persistent products can usually be obtained by grazing management (pasture planning), provided this recognises the time required to allow worm larvae to die off before sheep are re-introduced. The cost-benefit should also be considered, in comparison to grazing management

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 recommended. However, a primer drench should routinely be used with all slow release 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 10) 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.

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

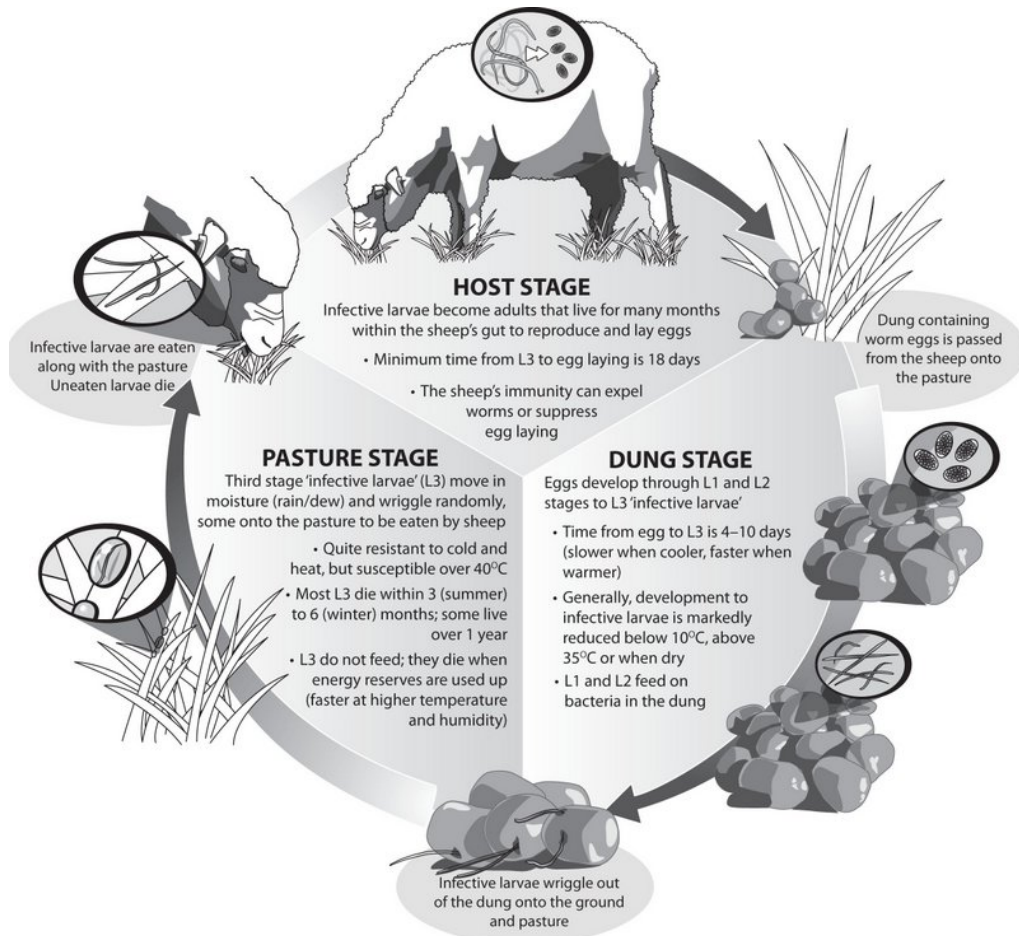
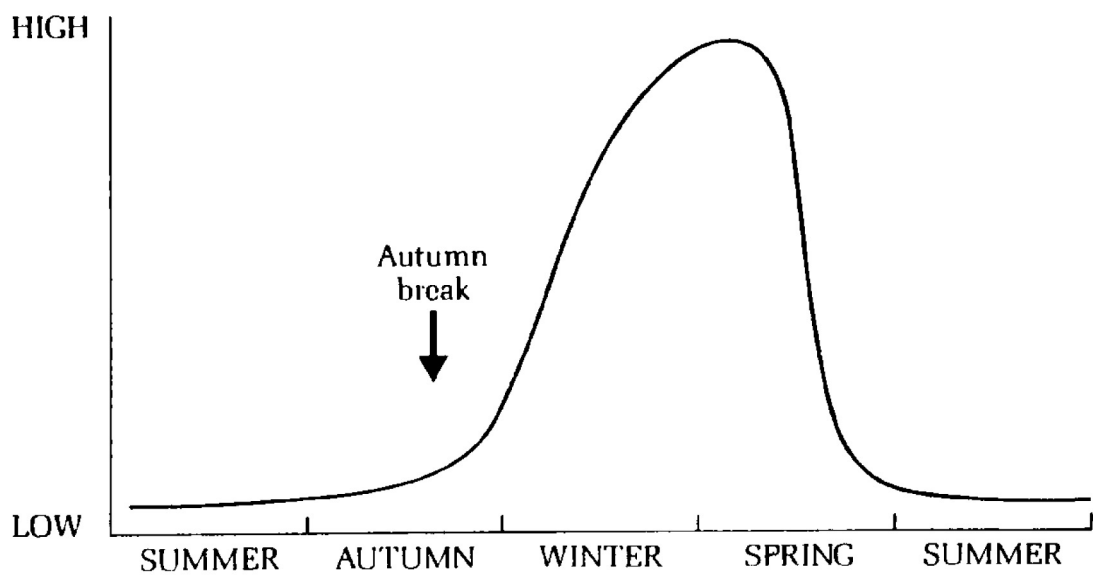


Figure 1. The life cycle of sheep roundworms



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: Factors contributing to paddock contamination with worms

The following table applies mainly to brown stomach worm (*Teladorsagia circumcincta*), black scour worm (*Trichostrongylus* species) and barber's pole worm (*Haemonchus contortus*).

Factor	Time or conditions			Effect
Minimum time before worm eggs can become infective larvae.	4–10 days			Short graze periods (less than 4 days) prevent 'auto-infection' (sheep becoming infected by larvae arising from worm eggs the same mob have recently deposited onto the pasture).
Conditions required for significant numbers of worm eggs to hatch and become infective larvae.	4–10 days of: Brown stomach worm: Temperature: daily maximum >8°C ¹ Moisture in this time: >10–15 mm rainfall ² Black scour worm: Temperature: daily maximum >12°C for <i>T. vitrinus</i> or >15°C for <i>T. colubriformis</i> Moisture in this time: >10–15 mm rainfall ³ Barber's pole worm: Temperature: daily maximum >18°C ¹ Moisture in this time: >10–15 mm rainfall ³			Unsuitable conditions prevent eggs developing into infective larvae. <i>Note:</i> The eggs of the small brown stomach worm are much more tolerant of cold and dry conditions, and in general, grazing management has less effect on its control. <<Footnotes for information to the left ¹ Some hatching of worm eggs of all species can occur below these daily maximum levels, but this is usually at a small and insignificant rate. ² Brown stomach worm eggs can develop at low rates without rainfall even in a relatively dry faecal pellet. ³ Development to infective larvae may occur without rainfall if soil moisture profile is high.
Maximum time worm eggs can live awaiting suitable hatching conditions.	Brown stomach worm: 21 days Some brown stomach worm eggs may survive for longer periods. Once hatched, infective larvae can remain in the faecal pellet until conditions are more suitable. Black scour worm: 16 days Once hatched, infective larvae can remain in the faecal pellet until conditions are more suitable. Barber's pole worm: 5 days			Prolonged periods without the right conditions (temperature/moisture) for egg development will result in the eggs dying. This lowers the worm-risk of paddocks.
The time for about 90% of the barber's pole worm infective larvae (L3s) to die (making paddocks low worm-risk). Note: Larvae of brown stomach worm and black scour worm can survive longer because they can remain in the faecal pellet for extended periods.		Maximum temperature (°C)	Time for 90% larvae to die	L3 larvae do not feed. While waiting to be eaten by sheep, they wriggle randomly in drops of moisture, more so in warmer conditions. Increased activity in warm weather depletes their energy reserves faster, hastening death. In extremely hot, dry and windy conditions, the larvae dry out and die.
	Cold	less than 15	4 months	
	Warm	about 22	3 months	
	Hot	about 35	1.5 months	
	Very hot	more than 40	1–2 weeks	
Minimum time for infective larvae eaten by sheep to mature and lay eggs (the 'pre-patent period').	Minimum of 18 days for most sheep roundworms.			Worm larvae eaten by sheep soon after an effective drench will take at least 18 days before they can lay eggs. During this period after administering an effective drench, sheep are not re-infecting the pasture.

Appendix 3: 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.



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