



WORM CONTROL PROGRAM

Summer rainfall/slopes and plains

A regional worm control program from WormBoss





WORMBOSS WORM CONTROL PROGRAM

Summer rainfall/slopes & plains

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WormBoss worm control program

Summer rainfall/slopes and plains

Program summary

The WormBoss worm control program for the summer rainfall/slopes and plains 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 low worm-risk paddocks for lambing and weaning by preventing contamination with worm larvae in the 2 to 5 months before they are needed. (Refer to the table on page 5 for the number of months required for your location). In this time, spell paddocks, graze with sheep for up to 21 days after the protection period (when it is killing worms) of an effective drench¹, or graze with cattle.

2. Breed and feed for worm-resistant sheep

- Use rams with better than average worm egg count (WEC ASBVs²) 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

- Prior to the October–November drench.
- Pre-lambing.
- Ewes before shearing, lamb-marking and weaning.
- Weaners from weaning to shearing: every 4–6 weeks (summer) or 6–8 weeks (winter) after a drench.
- Late February.
- From March to October, 4–6 weeks after significant rain (20+ mm) that also has follow-up rain (10+ mm) in the following few weeks.
- **And at other non-routine times as described in the *Drench Decision Guide*.**

4. Drench³ or use Barbevax[®] at recommended times

- If using Barbevax, follow the prescribed program (see [‘When to WormTest and when to drench and use Barbevax[®]’](#))
- In October/November:
 - ♦ *If the grass is green and actively growing in these months:*
Drench all sheep with an effective drench for barber's pole worm, scour worms and nodule worm. A prior *WormTest* will indicate whether a long-acting product could be needed.
 - ♦ *If the grass is brown or not actively growing in these months:*
Drench young sheep (less than 18 months old) with an effective short-acting drench against barber's pole worm, scour worms and nodule worm. *WormTest* in 4–6 weeks after the drench.
- Drench lambs at weaning (this may coincide with October/November drench).
- Drench all introduced sheep with a combination of no less than 4 unrelated drench groups with at least one of these being the newest drench actives: monepantel (Zolvix[®]) or derquantel (with abamectin—Startect[®])⁴.
- Drench individual sheep showing obvious signs of worm-related illness and *WormTest* the mob.
- At other times, use the *Drench Decision Guide* to make drenching decisions.

5. Manage drench resistance

- Conduct *DrenchTests* every 2–3 years. Use *DrenchCheck-Day10s* between *DrenchTests*.
- Avoid unnecessary drenching.
- Use effective drenches and multi-active⁴ combinations where possible.
- Use short-acting treatments. Reserve long-acting products for specific purposes or high worm-risk times.
- Rotate among all effective drench groups⁴ for each mob (and each paddock where possible).
- Calibrate your drench guns, dose to the heaviest sheep and follow label instructions.
- Use of Barbevax[®] vaccination should slow the rate of development of drench resistance.

¹This drench must be tested and shown to be highly effective on your property

²ASBVs=Australian Sheep Breeding Values.

³Drench refers to anthelmintics regardless of route of administration

⁴Drench 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](#).

This is an up-to-date, integrated regional worm control program for sheep in the summer rainfall/slopes and plains region of New South Wales and Queensland. It builds upon earlier programs (including from the state departments of primary Industries: NSW DPI and Qld DAFF) and accumulated knowledge, as well as new information from the Integrated Parasite Management in Sheep project, funded by Australian Wool Innovation and the Sheep CRC.

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 summer rainfall/slopes and plains region?

This region covers the slopes and plains of northern NSW and southern Queensland that have summer-dominant rainfall, averaging 400 to 650 mm per year. Summers are hot and winters are moderately cold with more frosts in the eastern parts.

The southern and northern boundaries are lines running east-west through Warren, New South Wales and through Roma, Queensland, respectively. The eastern boundary runs north from Gilgandra (NSW) to Siding Springs just west of Coonabarabran, then through Narrabri, Yetman and Texas, then south of Warwick, and then along the range north to Kingaroy (Qld). The western border goes from Mitchell (Qld) in the north, to Bollon, Goodooga, and Brewarrina, ending between Nyngan and Cobar (NSW) in the south.

Other towns in this zone are Walgett, Coonamble, Wee Waa, Moree, Mungindi, Dirranbandi, St George, Goondiwindi, Inglewood, Moonee, Surat, Millmerran, Chinchilla, Dalby and Toowoomba.

This region corresponds to the WestWorm (NSW DPI) and Wormbuster 1 (except Stanthorpe), 2a and 2b (Qld DAFF) zones.

These boundaries are approximations only as seasonal conditions vary.

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

What worms are covered in this program?

Roundworms

The most important roundworms in this region:

- | | |
|-------------------------------|-----------------------------------------------------|
| • Barber's pole worm | <i>Haemonchus contortus</i> |
| • Scour worms | |
| ♦ Black scour worm | <i>Trichostrongylus colubriformis</i> |
| ♦ Small brown stomach worm | <i>Teladorsagia (Ostertagia) circumcincta</i> (NSW) |
| ♦ Thin-necked intestinal worm | <i>Nematodirus</i> species (in young sheep) |

Important but only occasionally seen worms:

- | | |
|---------------|------------------------------------|
| • Nodule worm | <i>Oesophagostomum columbianum</i> |
|---------------|------------------------------------|

Less important worms:

- | | |
|-------------------------|----------------------------------------|
| • Small intestinal worm | <i>Cooperia</i> species |
| • Large bowel worm | <i>Oesophagostomum venulosum</i> (NSW) |

Liver fluke

In this region liver fluke only occurs in imported sheep. When sheep are brought here from areas with liver fluke, include a triclabendazole drench (which is effective against all stages of liver fluke) with quarantine treatments for worms.

Other worms

Gastro-intestinal parasites of minor importance, such as stomach fluke and tapeworm, are not covered.

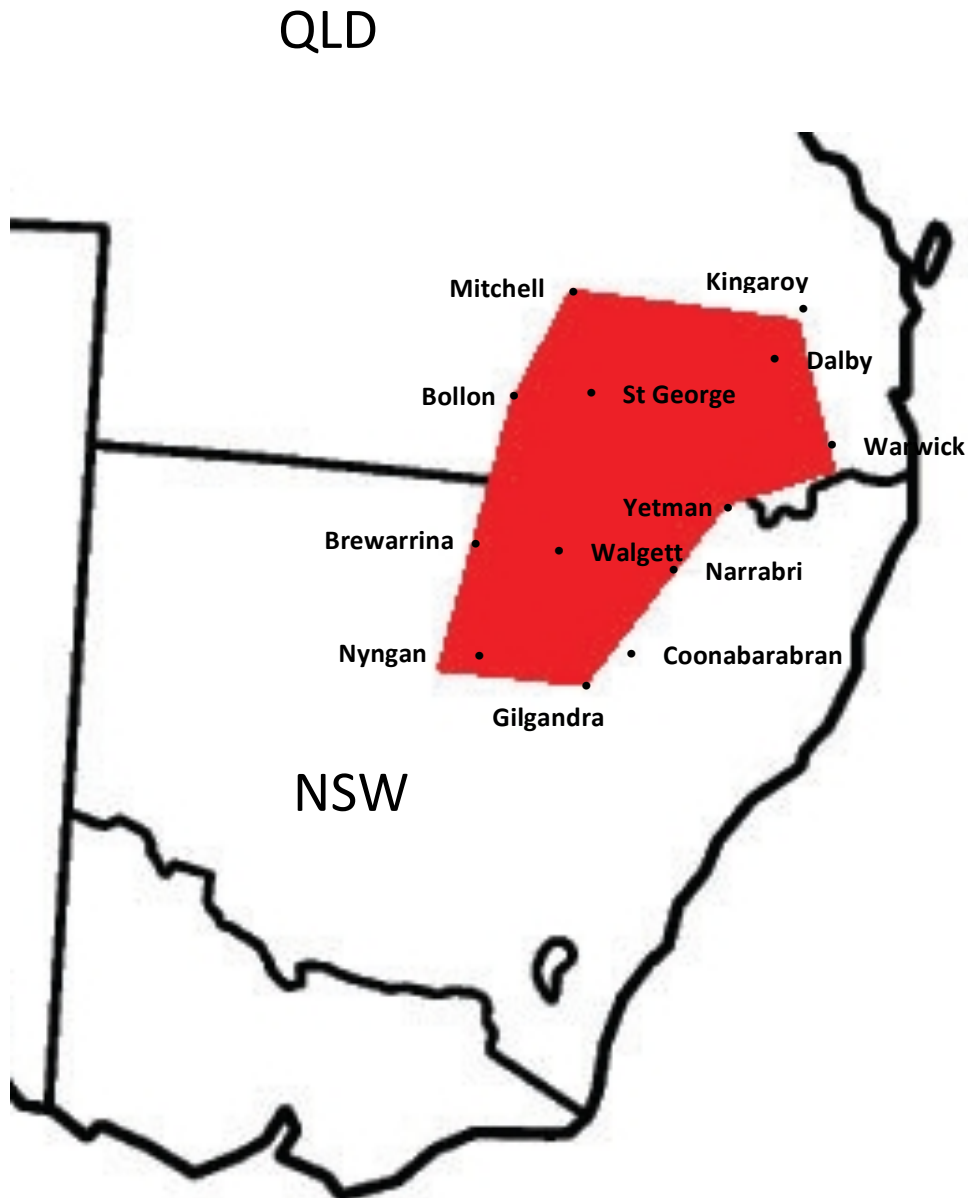


Figure 1. The summer rainfall/slopes and plains region.

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.

The last two are used to prepare ‘low worm-risk’ paddocks for lambing ewes and weaners.

How are low worm-risk lambing and weaning paddocks prepared?

Ewes temporarily lose some of their immunity to worms at and after lambing. As a result, they contribute greatly to the seasonal increase in worm numbers and subsequent infection of lambs.

Weaners are also highly susceptible to worms. Low worm-risk weaning paddocks give weaners a good start so they can build immunity without suffering high initial infections.

To prepare a low worm-risk paddock

Whether the paddock is for lambing ewes or for weaned lambs the method of preparation is the same. However, the length of preparation will vary according to the time of the year the paddock first needs to be used. Refer to Table 1. (below) to find out how long you need to prepare your paddock.

Preparation: In the months (see Table 1. below) before it is required for use as a lambing or weaning paddock, prevent contamination of the paddock with sheep (and goat or alpaca) worm eggs by any combination of these:

- spelling (including cropping and haymaking)
- grazing with sheep for up to 21 days after the protection period of a drench shown to be effective (in a *DrenchTest*) on your property. The protection period of a drench is when it is killing worms: 1–2 days for short-acting drenches, weeks or months for persistent products.
- grazing with cattle

Table 1. Months of preparation required for low worm-risk paddocks

The first month weaning or lambing starts	Eastern areas of this worm control region*	Western areas of this worm control region**
July, August, September or October	5	4
November or December	4	3
January, February, March or April	3	2
May or June	4	3

* includes towns such as Narrabri, Moree, Warwick and Dalby

** includes towns such as Nyngan, Walgett, St George and Mitchell

Other ways to prepare low worm-risk paddocks

Rotational grazing with short graze periods alternated with rest periods can greatly reduce the number of worm larvae on pasture, especially barber’s pole worm. While these systems (e.g. planned grazing, cell grazing, techno-grazing and intensive rotational grazing) are outside the scope of this publication, and may not be applicable to producers in this region, they use the principles found in [Appendix 2: Factors contributing to paddock contamination with worms](#).

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 or use Barbervax®

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. Pale skin and eyes, bottle-jaw, weight loss, a tail in the mob, and deaths may mean that your sheep need drenching. If so, these signs occur well after production losses from worms are already occurring in the mob. *WormTests* give early warning of 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.

WormTest just before sheep are mustered for routine management events. Also, *WormTest* at 4–6 week (summer) or 6–8 week (winter) intervals after a drench is given or, if a drench was not required, after a suitable period, as shown by the *Drench Decision Guide*.

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.

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

WormTest at least one in every three mobs that are similar regarding drenching history, paddock type and class of sheep.

Testing representative mobs saves the cost of testing all mobs. But this assumes the mobs, their paddocks and drenching history are very similar. If in doubt, test additional mobs.

When should *WormTests*, drenches and Barbervax® vaccination be routinely done?

The Barbervax® program is an optional strategy to control barber’s pole worm; it will not control other worms. Routine drenching (pre-lambing for breeding ewes and weaning for lambs) and routine *WormTest* times will still apply, however non-routine drenching will be reduced when Barbervax is used correctly. Protection against barber’s pole worms requires three initial ‘primer’ vaccinations at 3–4 week intervals. In the next year of use, one priming vaccination will provide protection from 5 days later. A vaccination schedule can be customised by a professional advisor.

Table 1. Routine Barbervax vaccination times

<p><i>Lambs or hoggets not previously vaccinated</i></p> <ul style="list-style-type: none"> • V1: lambs at lamb marking; hoggets during October. • V2: 3–4 weeks after V1. • V3: 3–4 weeks after V2. • V4–V6: after V3, give at 6-weekly intervals while protection is required. 	<p><i>Hoggets vaccinated as lambs the previous year</i></p> <ul style="list-style-type: none"> • V1: Give in November/December (earlier if spring is wet) • V2–V5: after V1, give at 6-weekly intervals while protection is required.
<p><i>Breeding ewes not previously vaccinated (assumes a spring lambing)</i></p> <ul style="list-style-type: none"> • V1: 8–9 weeks pre-lambing. • V2: 4–5 weeks pre-lambing. • V3: 1–2 weeks pre-lambing. • V4: lamb marking. • V5 onwards: after V4, give at 6-weekly intervals while protection is required. 	<p><i>Breeding ewes vaccinated the previous year</i></p> <ul style="list-style-type: none"> • V1: 1–2 weeks pre-lambing, with an effective pre-lambing drench (for scour worms and early barber’s pole worm) and move ewes to a low worm-risk lambing paddock prepared in previous 6 months. • V2: lamb marking. • V3–V6: after V2, give at 6-weekly intervals while protection is required.

Note: V=vaccination, the number (1–6) refers to first, second (and so on) vaccination in the series given in one barber’s pole worm season.

It is also important to follow the routine drench and *WormTest* times shown below.

Ideally, a mob WormTest should be done 4–5 weeks after an effective (i.e. not priming doses) vaccination, from the third vaccination onwards, so that the result is known before the next vaccine muster.

Routine drenching times

In October/November:

- *If the grass is green and actively growing in these months:*
All sheep should be given an effective drench for barber's pole worm, scour worms and nodule worm. However, if a *WormTest* (recommended before drenching) is greater than 500 epg, and seasonal conditions are good, your sheep may need extra protection against barber's pole worm, such as a mid-length or long-acting drench (if effective on your property).
If a persistent product is used, the sheep can be kept on the same pasture or moved elsewhere according to your management needs. If a short-acting drench is used, move sheep to low worm-risk pastures (see page 5) with good feed. *WormTest* in 4–6 weeks after a short-acting treatment. If mid-length or long-acting treatments are used, follow the recommendations for mid-length and long-acting treatments on pages 12 and 13.
- *If the grass is brown or not actively growing in these months:*
Young sheep (less than 18 months old) will need an effective short-acting drench against barber's pole worm, scour worms and nodule worm. *WormTest* in 4–6 weeks after the drench.

At weaning: This may coincide with the October/November drench, if not, always drench at weaning.

Routine WormTest times

WormTests can be done at any time; however there are also set times to *WormTest* (preferably with a larval culture in warm/wet times to check for barber's pole worm):

- prior to the October–November drench
- pre-lambing
- late January if drenching was not done in October/November
- late February if drenching was done in October/November (except weaners, see final point below)
- from March to October, 4–6 weeks after significant rain (20+ mm) that also has follow-up rain (10+ mm) in the following few weeks
- ewes prior to mustering (e.g. for crutching, joining, shearing) as directed by the *Drench Decision Guide*
- weaners from weaning to shearing: every 4–6 weeks (summer) or 6–8 weeks (winter) after a drench

WormTest more often in high rainfall years and less often in very dry years. However, when sheep congregate on smaller areas due to tall thick pastures, heavy rain/flooding or bore drains *WormTest* more often.

Check the intestines: Nodule worm can be a problem in this area; check for signs when any sheep die or are killed for rations. Open the sheep's abdomen and find the large and small intestines. Examine the outside wall of each for firm white pimples or nodules. If these are present, you should routinely drench in May with a drench that contains either a macrocyclic lactone (ML) or a benzimidazole (BZ).

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 next page) to weigh up important factors when deciding when to drench or *WormTest* on your property. These factors are signs of worms, time since last drench, the persistence of the last drench, *WormTest* results, recent rainfall, and condition of sheep and pastures.

If drenching is done for other reasons (such as an early drench before holidays or harvesting), recommence *WormTests* 4–6 weeks (summer) or 6–8 weeks (winter) after the drench was given. Then use the *Drench Decision Guide* to decide when to drench or *WormTest* again.

What samples should be collected for WormTests?

Sheep do not need to be yarded for a *WormTest*. Collect fresh dung from the paddock. Obtain *WormTest* kits or sample collection details from laboratories or resellers in your area. Follow the instructions provided in the kit.

- Avoid delays in transit (when worm eggs can hatch) by collecting and posting early in the week.
- Ensure samples are kept cool, but not refrigerated, before sending.

If you do your own worm egg counts, use the 'bulk' sampling method where all of the dung is collected into one container.

- Collect 3 pellets per pile of dung from at least 20 individual piles of fresh dung.
 - ♦ In barber's pole worm areas collect from 40 piles of dung if the mob has over 200 sheep.
 - ♦ Choose pellets of equal size so that each sheep is equally represented.
 - ♦ If dung consistency is runny, use a plastic spoon. Don't avoid runny or soft dung.
 - ♦ Collect lamb and ewe samples separately.
- Dung should be very thoroughly mixed together before preparing your solution for counting.
- Count 5 chambers from the sample.

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* is reliable and helps to simplify decisions. There is a version of the *Drench Decision Guide* for each WormBoss region.

The guides consider

- 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

Results from the *Drench Decision Guide* can be applied to mobs without a *WormTest* if other mobs (same class, and similar drenching and paddock histories) have been tested. If in doubt, *WormTest* the mob.

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 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 the drench 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.

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, 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 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. 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 effective drenches*: these are known to reduce the worm egg count on your property 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.
2. *Use a combination of two or more groups where possible*, as fewer worms are able to resist more than one group at a time.
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 page 12, '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, 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, 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 (including complying with withholding periods).
5. *After sheep have been drenched, graze them initially on paddocks already contaminated with worms likely to be less resistant to drenches* (except in the cases of lambing and weaning paddocks that specifically need to be low worm-risk). Eggs from surviving drench-resistant worms will be diluted by eggs and larvae already on the paddock and therefore not exposed to the drench (i.e. 'in refugia').

If sheep must be drenched onto low worm-risk paddocks do both of the following:

- i. When the sheep eventually leave these low worm-risk paddocks, treat them with an effective drench that is from a different group to the drench used when the sheep first went onto the paddock. The aim is to remove any drench-resistant worms surviving in the sheep after the first drench.
- ii. Ensure that the next time the paddock is grazed it is with a different mob of sheep. This second mob should have a moderate to high worm burden and their last treatment must be different from the treatment used on the first mob that grazed the low worm-risk paddock. This will dilute drench-resistant worms already on the paddock with more susceptible worms that the second mob is carrying. Note that grazing with cattle will not dilute the proportion of drench-resistant worms, but they will decrease the total number of worm larvae on this paddock.

NOTE: Treating less than 100% of a mob is **not** currently recommended in this region. The practice of leaving some sheep untreated was developed to reduce development of drench resistance. It is successful in some areas where barber's pole worm is not a major threat.

Using Barbervax® vaccine for barber's pole worm

The use of Barbervax should slow the rate of development of drench resistance because fewer drenches will be used. It is unlikely that barber's pole worm will develop resistance to this vaccination.

How can persistent treatments be used effectively?

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).

Both 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. Secondly, persistent treatments have a longer time at the end of their protection period where the active concentration has dropped to a level where partly resistant worms may survive and reproduce.

Use primer and exit drenches with long-acting treatments

Primer drenches clear the sheep of any worms 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. Give a primer at the same time that a long-acting product is given.

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.

Mid-length treatments need exit drenches

Resistance can develop to mid-length treatments in the same way as to long-acting treatments. While primer and exit drenches are desirable with mid-length treatments, they are rarely cost-effective because of the relatively short protection period compared to long-acting products. However, the use of an exit drench is highly recommended two weeks after the end of the protection period stated on the label.

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 *WormTest* at 60 days and 90 days after it is given to see 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 30 and 60 days.

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 survival

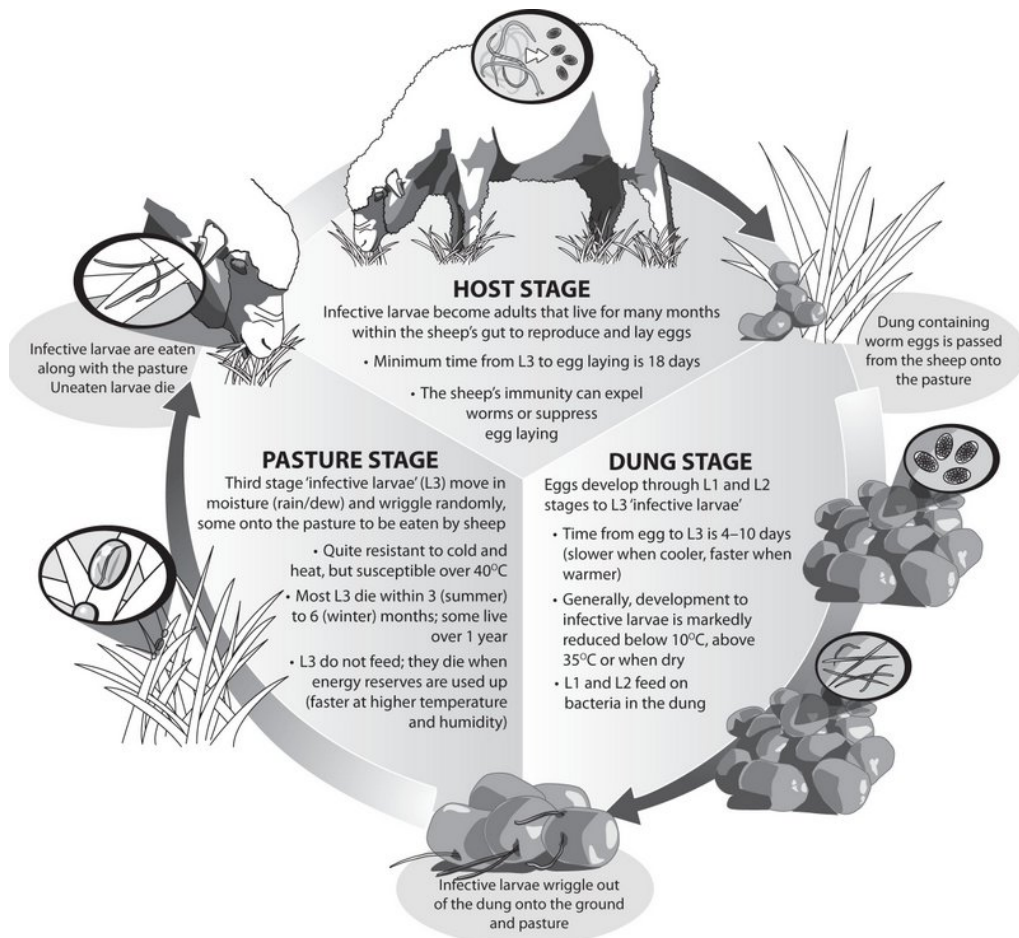
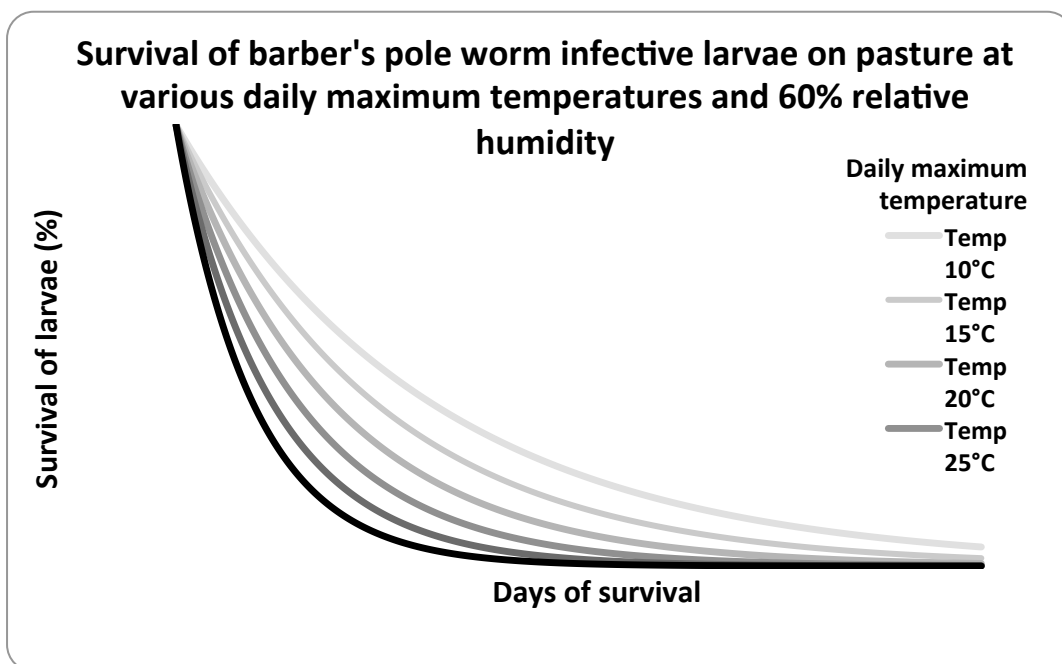


Figure 1. The life cycle of sheep roundworms



Source: Modeled from death rate of the L3 population in 'Simulation of pasture larval populations of *Haemonchus contortus*' by IA Barger, PR Benyon & WH Southcott. Proceedings of the Australian Society of Animal Production (1972) 9: 38

Figure 2. Survival of barber's pole worm infective larvae on pasture

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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