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WORM CONTROL PROGRAM

NSW non-seasonal rainfall

A regional worm control program from WormBoss

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WORMBOSS WORM CONTROL PROGRAM

NSW non-seasonal rainfall

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Acknowledgement:
This program was developed by the Sheep CRC, which wishes to acknowledge the major contribution to this publication from the NSW DPI program, 'DrenchPlan', which was developed as a cooperative venture involving:
NSW Department of Primary Industries—veterinarians, parasitologists and livestock officers
Livestock Health and Pest Authorities, NSW (formerly Rural Lands/Pastures Protection Boards)—District Veterinarians
CSIRO Division of Animal Health—research scientists
With assistance also from the private sector including primary producers, pharmaceutical companies and consultants.

Published: June 2012 **Updated:** November 2015

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ParaBoss is the project owned by Sheep CRC Ltd, The University of New England, Australian Wool Innovation Limited and Meat & Livestock Australia Limited that manages WormBoss.

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Program summary

The WormBoss worm control program for the non-seasonal rainfall region has five components that are effective when used in combination. Their effectiveness is reduced when not used in an integrated way.

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 up to 21 days after the protection period (when it is killing worms) of an effective drench[1], or graze with cattle.
   - Use 'Smart grazing' to prepare winter weaner paddocks.
2. **Breed and feed for worm-resistant sheep**
   - Use rams with better than average worm egg count (WEC ASBVs[2]) 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**
   - From March till October, *WormTest* 4–6 weeks after significant rain that has follow-up rain, including the autumn break.
   - Young sheep in May/June before the more severe winter weather arrives.
   - Pre-lambing (also include a larval culture to identify the worm types present).
   - A week prior to other management activities (such as crutching, joining, shearing and weaning).
   - *WormTest* at 6–8 week intervals after a short-acting drench was given. If using a persistent drench (including capsules and injections) then see 'Effective use of long-acting drenches'.
   - ***And at other non-routine times as described in the Drench Decision Guide.***
4. **Drench[3] at recommended times**
   - The 'first summer drench'. All sheep receive this when pastures are haying off in late spring. In very dry or drought years do a *WormTest* beforehand, as even this drench may be unnecessary and may cause increased selection for drench resistance.
   - Lambs at weaning. This may coincide with the 'first summer drench'. Autumn-drop lambs may also need an additional drench 4-8 weeks after weaning.
   - 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 sheep showing obvious signs of worm-related illness.
   - At other times, use the *Drench Decision Guide* to make drenching decisions.
5. **Manage drench resistance**
   - Conduct *DrenchTests* every 2–3 years. Use *DrenchCheck-Day10-14 between DrenchTests*.
   - Avoid unnecessary drenching.
   - Use effective drenches and multi-active[4] combinations where possible.
   - Use short-acting treatments. Reserve long-acting products for specific purposes or high worm-risk times.
   - Rotate among all effective drench groups[4] for each mob (and each paddock where possible).
   - Calibrate your drench guns, dose to the heaviest sheep and follow label instructions.

[1]This drench must be tested and shown to be highly effective on your property
[2]ASBVs=Australian Sheep Breeding Values.
[3]Drench refers to anthelmintics regardless of route of administration
[4]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 5: Drench groups and actives.

This is an up-to-date, integrated regional worm control program for sheep in the non-seasonal rainfall region of New South Wales. It builds upon earlier programs (including from the NSW Department of Primary Industries) and accumulated knowledge, as well as 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
- 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 non-seasonal rainfall region?

This region generally has non-seasonal or uniform rainfall (350–850 mm) extending to winter dominant rainfall areas within the eastern Riverina. Some areas tend to summer dominance with respect to rainfall (notably the Monaro). There are four sections within this region:

- The south-western area (including the eastern Riverina) with hot summers and cool winters (includes the towns of Condobolin, West Wyalong, and Wagga Wagga).
- The tablelands area with warm summers and cold frosty winters (includes the towns of Bathurst, Orange, Yass, Young, Goulburn, Cooma); and
- The coastal area with warm to hot summers that are more humid and cool winters (includes the towns of Bega, Batemans Bay).
- The eastern Riverina (includes the towns of Finley, Narrandera and Griffith, Lockhart and Corowa) with hot summers and more winter rainfall dominance.

The region extends from an east-west line through Warren in the north to the NSW/Victoria border and west from the coast to a line from Nymagee (west of Nyngan and Tottenham) through to the Victorian border just west of Finlay.

This corresponds with the DrenchPlan region (NSW DPI)

These region boundaries are approximations only as seasonal temperature and rainfall variations affect worms.

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

What worms are covered in this program?

Roundworms

The most important roundworms in this region are:

- Scour worms
  - Black scour worm — *Trichostrongylus colubriformis*; *Trichostrongylus vitrinus* (increases in the south)
  - Small brown stomach worm — *Teladorsagia* (*Ostertagia*) *circumcincta*
- Barber's pole worm — *Haemonchus contortus*

Also important but mainly for young sheep

- Thin-necked intestinal worm — *Nematodirus* species

Barber's pole worm

In this region, barber's pole worm is often a problem, therefore the Barbervax® vaccine should be considered if it is 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.

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

Liver fluke

Liver fluke is an internal parasite that occurs in parts of this region depending on the distribution of the intermediate host snail. It can affect sheep severely, sometimes causing deaths. The life cycle differs from the simple life cycle of roundworms, so control strategies are different.

This program relates to roundworms. To control liver fluke, see Appendix 1: Liver fluke control.

Other worms

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

Figure 1. The NSW non-seasonal rainfall 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	Cooler tablelands areas of this worm control region*	Hotter 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 Bathurst, Orange, Goulburn, Yass*

*** includes towns such as Tottenham, Condobolin, West Wyalong, Narranderra*

To prepare a winter weaner paddock using 'Smart grazing'

The paddock(s) that will be used by weaners after the autumn break should previously only be grazed by sheep that have received an effective summer drench, or adult cattle (over 12 months old). To minimise contamination with worm eggs, graze only for 30 days after each short-acting drench is given. A similar stocking rate to continuous stocking will be achieved by stocking at 2½–3 times your normal stocking rate.

If there is excess feed, the summer drenches can be 'staggered' for different mobs, so as to provide a longer intensive grazing period, as removing excess feed enhances the kill of worm larvae with summer heat.

Give the weaners an effective drench before they enter the 'Smart grazed' paddock after the autumn break.
*'Smart-grazing' is a specific effective strategy developed by the Mackinnon Project, University of Melbourne, in Victoria: see Appendix 4. 'Smart grazing for weaner worm control'.

Other ways to prepare low worm-risk paddocks:

Rotational grazing with short graze periods alternated with rest (e.g. planned grazing, cell grazing, techno-grazing and intensive rotational grazing) is outside the scope of this publication. However they use the principles outlined in Appendix 3: 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

Why check worm burdens in sheep?

Checking worm burdens with a *WormTest* is essential for correct and timely drenching decisions. The result is healthy sheep, without unnecessary drenching. *WormTests* are the best basis for drenching decisions. Weight loss, a tail in the mob, pale skin and eyes, bottle–jaw, 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 *WormTest*s is a critical part of the WormBoss worm control program.

WormTest just before sheep are mustered for routine management events. Also, *WormTest* at 6–8 week 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 just representative mobs saves the cost of testing all mobs. But this assumes the mobs, their paddocks and drenching history are quite similar. If in doubt, test additional mobs.

When should *WormTests* and drenches be routinely done?

Routine drenching times

In this region there are 2 times when sheep should be drenched in most years without a prior *WormTest.* These are

- the 'first summer drench'
  All sheep receive this when pastures are haying off in late spring/early summer). In dry or drought years do a *WormTest* beforehand as a drench may be unnecessary and could cause increased selection for drench resistance. In the eastern Riverina, this could be delayed until immediately post–harvest and be based on a *WormTest*.
- lambs at weaning
  This may coincide with the 'first summer drench'. Weaned lambs are highly susceptible to worms, especially from the stress of weaning. There may also be high worm–risk in wet seasons. Drenching will help weaners to achieve the growth rates needed for survival. Autumn–drop lambs may also need an additional drench 8 weeks after weaning. For spring–drop lambs, additional drenching after weaning should be done on the basis of *WormTest* results.

Routine *WormTest* times

WormTests can be done at any time, however there are certain routine times to *WormTest*:
(Note: a larval culture (larval differentiation) is useful with all *WormTests*, and should at least be done occasionally to identify whether barber's pole worm are common on the property. However, they should particularly be done on properties with a history of barber's pole worm or otherwise as shown below.)

- from March till October, *WormTest* 4–6 weeks after significant rain (20+ mm) that has follow–up rain (10+ mm) within a few weeks, including the autumn break
- young sheep in May/June before the more severe winter weather arrives (may not be required in the drier eastern Riverina)

- pre-lambing (also include a larval culture if barber's pole worm have been a problem in the past year) (may not be required in the drier eastern Riverina)
- prior to other management activities (such as crutching, joining, shearing and weaning) as directed by the *Drench Decision Guide*

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 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* 6–8 weeks after the drench was given. Then use the *Drench Decision Guide* to decide when to drench or *WormTest* again.

Barber's pole worm in this region is common. If summer and/or autumn are 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 (which may or may not be 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 fresh dung (less than 10 minutes after being dropped) from the paddock. Obtain *WormTest* kits or sample collection details from laboratories or vets or rural stores 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 properly sealed (airtight) and 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.
  - 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* resultsthe 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-Day14* is used to check individual drenches at any time. Regularly do *DrenchCheck-Day14s* 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 A sample is taken from sheep prior to the drench (Day 0) to act as a 'control' or comparison. Each of the groups is drenched and dung samples are collected from all of the sheep 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-Day14

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

The *DrenchCheck-Day14* involves two *WormTests*: the first on the day of drenching (usually at a routine*WormTest* time) and the second 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 adviser.

For more detail see the fact sheet 'Checking for drench resistance with a *DrenchCheck–Day14'* 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 5: 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 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 weaner 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.

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—up to 3-4 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. This can be confirmed by doing worm egg counts at set times after the long-acting treatment is applied e.g. 30, 60 and 90 days, or at convenient management events such as prior to lambmarking and weaning. 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. Primer and exit drenches are desirable with mid-length treatments, but they may not be 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-Day14* (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: Liver fluke control

Liver fluke (*Fasciola hepatica*) only occurs where the intermediate host (lymnaeid snails) are present. These snails are found where there are slow-moving creeks, swamps or springs and they can survive in mud when water flow temporarily stops. However, the snail is not necessarily present in all such areas.

Liver fluke may not be present on all paddocks or properties in a 'flukey' locality.

Roundworms are often specific to one type of animal, but liver fluke can infect many species including cattle, sheep, goats, alpacas and horses, as well as humans and wild animals

Prevention

Grazing management can help prevent liver fluke infection. Unfortunately, there is currently no effective method to breed for host resistance to liver fluke.

If liver fluke is present on a property, infection can be prevented or minimised by

- isolating the areas that harbour the snail, using fencing
- conducting earthworks to deepen shallow water, or to improve drainage
- repairing broken pipes and troughs that have resulted in permanent wet areas
- avoiding grazing of snail-infested areas by the most susceptible animals (sheep, goats, alpacas and young cattle)

Detection

Testing for liver fluke can be done using the dung samples sent for a *WormTest*. A fluke test, which uses a different method to that used for roundworms, must be specifically requested.

If you don't know whether your sheep are infected with liver fluke, test three times a year (autumn, winter and summer) for at least two years (i.e. 6 tests).

Testing will show whether liver fluke is present and to what extent.

You can also determine which paddocks are affected by testing mobs that have only been run in a particular paddock since the last fluke-treatment.

If fluke egg counts for a particular paddock are frequently high (greater than 25–50 eggs per gram), there may be significant production losses. Reconsider your grazing strategies for the affected paddocks and see if fluke-affected areas can be fenced off.

If results at the three testing times are not always positive, then continue testing at the specified times to decide whether to drench.

If all six tests have been negative and the livers of dead or slaughter sheep have not shown any signs of liver fluke, it is likely that the lymnaeid snails are not present on your property to act as a host for liver fluke. Drenching for fluke will not be required (except to remove fluke from sheep brought onto the property).

A blood test (antibody [ELISA] test) is also available from various laboratories, for example, the NSW Department of Primary Industries State Veterinary Laboratory at Menangle. Also, a faecal antigen test for fluke is available there as well as through Charles Sturt University's Veterinary Diagnostic Laboratory.

Response

Any positive fluke egg count is significant and indicates treatment is needed.

If testing for two years confirms that sheep are infected at all test times, then ongoing testing can be stopped. In this case, three routine treatments for liver fluke should be given to sheep that have been grazing the affected paddocks in

- April–May
- August–September
- February

Some treatments for roundworms (scour worms and Barber's Pole worms) will control various stages of liver fluke. Check the label as some are only effective against mature fluke (see Table 1.).

The most important treatment is carried out in April–May and should be based on the flukicide, triclabendazole, which is effective against all stages of the fluke found in the sheep. If treatments are also required in August–September and/or February, one or both of these treatments should be a flukicide other than triclabendazole (if this was used in April). This treatment rotation will reduce the rate of development of fluke resistant to triclabendazole.

Flukicide resistance is common but not well-documented. A follow-up fluke egg count conducted 30 days after the April-May or the August treatment will indicate if the fluke have survived the flukicide.

When bringing in sheep from another property, consider including a fluke treatment in the quarantine drench if their fluke status is unknown. Bear in mind that adult liver fluke can live for several years inside host animals.

Table 1. Fluke treatments and the age of fluke from which they are effective

Active	Age of fluke killed
Triclabendazole	All stages
Albendazole	From 12 weeks
Closantel	From 8 weeks
Closantel plus oxfendazole	From 6 weeks
Closantel plus albendazole	From 8 weeks
Oxyclozanide plus levamisole	From 12 weeks

Source: from *Liver fluke disease in sheep and cattle*, by J Boray (March 2007) NSW DPI Primefact 446

The following drench actives do not control liver fluke:

- moxidectin, abamectin or ivermectin
- oxfendazole and fenbendazole
- levamisole
- naphthalophos and pyraclofos
- monepantel
- derquantel
- praziquantel

Resistance to flukicides

Resistance has developed to various flukicides. Rotate between flukicides from different chemical groups, beginning with triclabendazole for the April–May treatment.

Resistance of liver flukes to flukicides can be checked, however, fluke egg counts may not be high enough to give a precise estimate of flukicide efficacy, nevertheless, they are still worth doing. You will need a fluke count carried out not long prior to drenching (up to 2 weeks before administering a fluke drench). Follow this up with another fluke count between 21 and 28 days after the fluke drench was given. If your flukicide is effective the fluke egg count will normally go down by at least 90%.

More detailed information on liver fluke can be found at the NSW DPI web site:

http://www.dpi.nsw.gov.au/agriculture/livestock/sheep/health

Appendix 2: Roundworm life cycle and larval survival

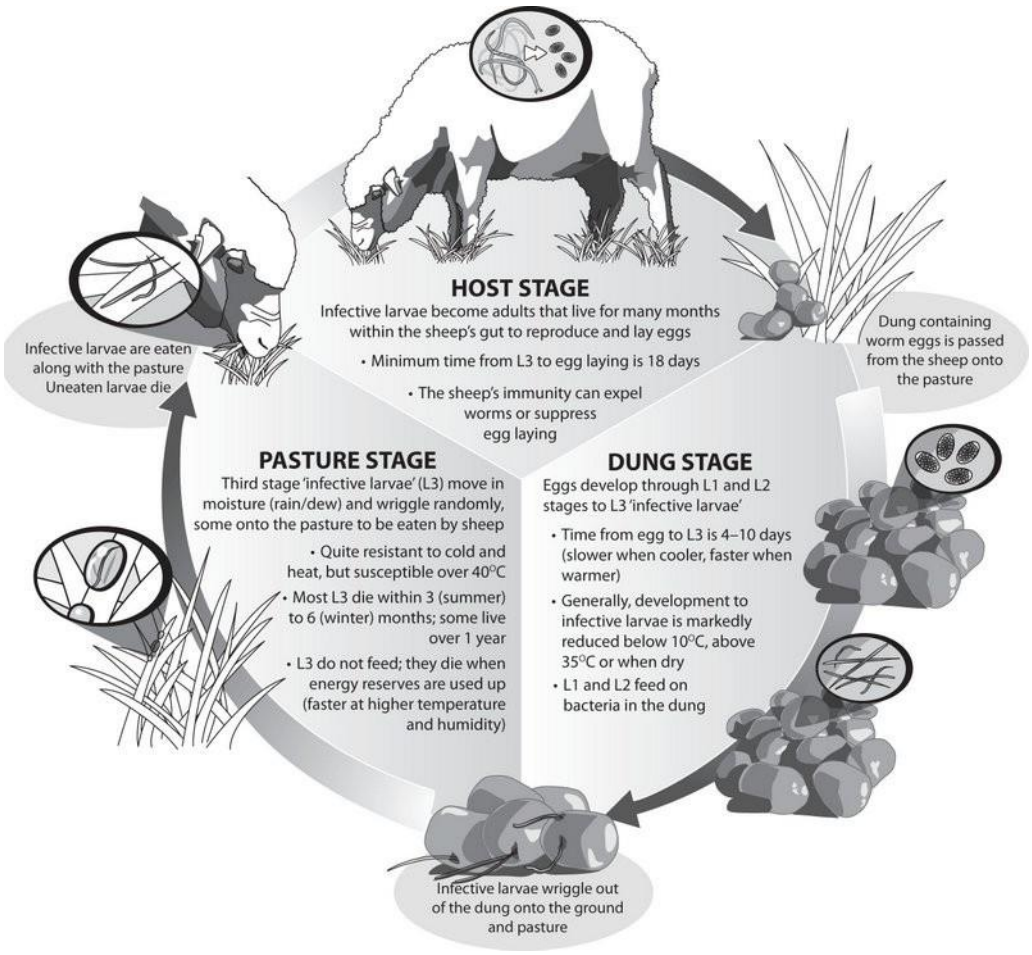
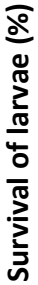


Figure 1. The life cycle of sheep roundworms



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 3: 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 *T. vitrinus* or >15°C for *T. colubriformis* 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. *Note:* 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.**	<table><tr><th></th><th>Maximum temperature (°C)</th><th>Time for 90% larvae to die</th></tr><tr><td>Cold</td><td>less than 15</td><td>4 months</td></tr><tr><td>Warm</td><td>about 22</td><td>3 months</td></tr><tr><td>Hot</td><td>about 35</td><td>1.5 months</td></tr><tr><td>Very hot</td><td>more than 40</td><td>1–2 weeks</td></tr></table>	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.
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 4: Smart grazing for weaner worm control

By Norman Anderson & John Larsen, Mackinnon Project, University of Melbourne

From the Mackinnon Project website (10 December 2011):
http://www.mackinnonproject.com.au/index.php?option=com_content&view=article&id=65&Itemid=1

Introduction

Smart grazing is an improved yet simple and reliable strategy for the control of worms in weaner sheep during their first winter. It can counter the negative effects of summer rainfall that reduces the effectiveness of the '2-summer treatment strategy' in the winter rainfall areas of southern Australia.

The why and how of 'Smart grazing'

Merino weaners are very susceptible to worms in their first winter. Consequently, they need to graze pastures that have as few worm larvae as is practicable. 'Smart grazing' combines intensive grazing for 30 days with each of the 2 'summer' drenches to ensure that virtually no worm eggs are deposited on a chosen pasture from the first summer drench (November) until after the autumn break (March–April), when the weaners are put into these pastures.

Intensive grazing means using 2½–3 times the normal stocking rate for no longer than 30 days after each of the summer drenches are given. After the intensive grazing period, the paddocks are de-stocked to allow the pastures to re-grow. This means that the total stocking pressure for the 'Smart grazed' paddock will be the same as that for a paddock continuously stocked at the farms normal stocking rate.

The intensive grazing will reduce pasture residues to around 800–1000 kg DM/ha after the first summer drench, and around 600 kg DM/ha after the second. If there is insufficient feed, the periods of intensive grazing can be reduced. On the other hand, if there is excess feed the summer drenches can be 'staggered' for different mobs so as to provide a longer intensive grazing period or cattle can be used as well.

Finally, the weaners must be drenched with an effective drench before they start grazing the 'Smart grazed' paddock after the autumn break.

Smart grazing on a typical farm

A typical self-replacing flock of 5,000 DSEs in southern Australia is made up of 1,500 ewes, 1,500 wethers and 1,000 weaners, running at a winter stocking rate of 15 DSE/ha.

70 ha of 'Smart grazed' paddocks must therefore be prepared for the weaners. Thus, 2600 DSE (70 x 15 x 2.5) are needed to stock the 70 ha at 2½ times the normal stocking rate for each of the two intensive grazing periods—this uses all of the wethers and 70% of the ewes on the farm.

A timetable for 'Smart grazing'

OCTOBER: Select the 'Smart grazing' paddock—choose one with a history of good winter pasture.

NOVEMBER: Give the first summer drench (this must be an effective product), then intensively graze the paddock at 2½–3 times the normal stocking rate.

DECEMBER: Remove the sheep to another part of the farm after 30 days intensive grazing. Ideally, the pasture residue should be 800–1000 kg DM/ha (2–3 cm in height).

JANUARY: Paddock remains unstocked until the second summer drench.

FEBRUARY: Give the second summer drench, then intensively graze the 'Smart grazing' paddock with the drenched sheep (again, not for greater than 30 days).

MARCH: Paddock remains de-stocked until the autumn break.

AUTUMN BREAK (MARCH–APRIL): Drench weaners and set-stock on the 'Smart grazing' paddock when pasture is greater than 600 kg DM/ha (1.5 cm). Weaners can remain there until spring but monitor their worm egg counts every 4–6 weeks.

Why does smart grazing work?

The intensive grazing periods

- reduce the amount of pasture dry matter, making the pasture less suitable for the survival of worm larvae
- ensure that there is no deposition of worm eggs on the pasture from the time of the first summer drench until the autumn break
- probably allow the drenched sheep to 'vacuum' up infective larvae in much the same way as cattle do when they are used in alternate grazing programs with sheep
- have the same cumulative stocking pressure from November to March as set-stocked paddocks grazed continuously by wethers
- are quite flexible, what must not be changed is the need (i) not to exceed 30 days grazing after each summer drench, and (ii) for a fully-effective product to be used at the summer drenches

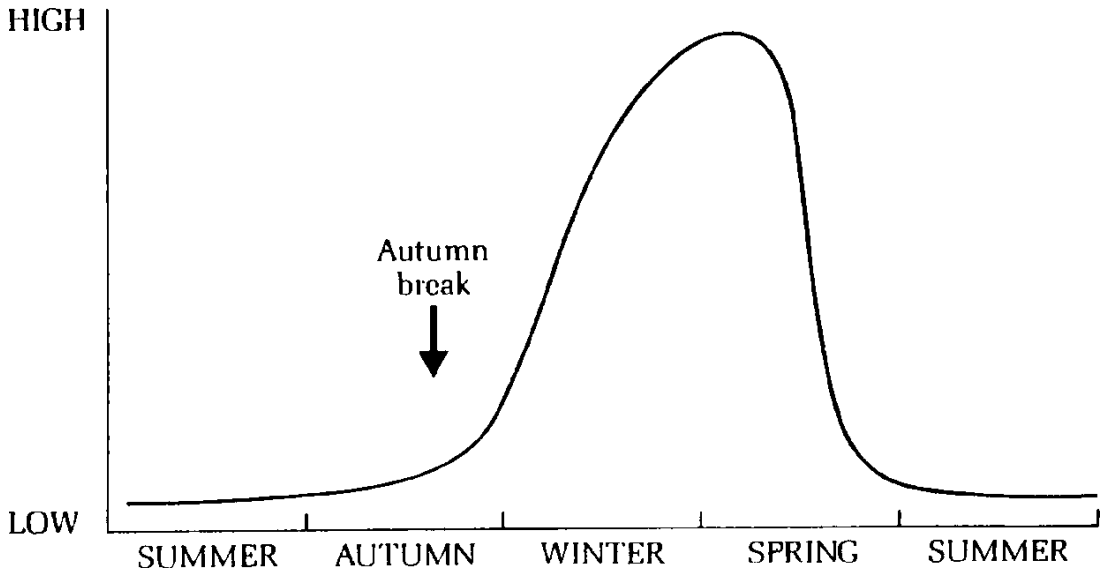
What are the benefits?

Results from a controlled experiment over 2 years in western Victoria show that, compared to weaners grazing paddocks prepared the usual way (grazed by wethers over the summer/early autumn), weaners grazing 'Smart grazing' plots

- grew 13% more clean wool (2.29 vs. 2.03 kg) which was 3.5% broader (17.1µ vs. 16.5µ)
- were 3 kg heavier in October (46.5 vs. 43.2 kg).

During winter, the egg counts from the 'Smart grazed' weaners didn't go higher than 250 epg, a trigger for drenching weaners used by many farmers and their advisers. In contrast, the weaners on the paddocks prepared by set-stocked wethers exceeded 400 epg in both years.

The numbers of worm larvae on the 'Smart grazed' pastures in winter were from one-half to a one-third of those on pastures in paddocks prepared by grazing with set-stocked wethers.



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 3. 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 5: 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 (*Moniezia*)	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 (levamisole)
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 (*Moniezia*)	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: [B]Broad-spectrum; [M]Mid-spectrum; [N]Narrow-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.