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WestWorm and FarWestWorm

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Introduction

Disease and production loss from internal parasites are one of the biggest health problems of Australian sheep. NSW Department of Primary Industries, CSIRO and Rural Lands Protection Boards (RLPBs), with assistance from others, have developed worm control programs for various parts of New South Wales. These programs have continued to evolve since they were first launched – WormKill 1984, DrenchPlan 1985, FarWestWorm 1998.

Figure 1. Sheep worm programs for NSW

The programs developed for New South Wales (see map) include:

- WormKill – northern NSW
- DrenchPlan – central and southern NSW
- WestWorm – north-western NSW
- FarWestWorm – western plains.

Each program is based on integrated worm management, relying not just on drenches, but also nutrition, grazing management to produce low-worm risk pastures, and breeding resistant sheep.

WestWorm and FarWestWorm programs

For sheep worm management, western NSW is divided into two major zones:

WestWorm

WestWorm encompasses the Rural Lands Protection Boards of Walgett, Moree, Narrabri, Nyngan, Coonamble, Condobolin and part of Brewarrina. (DrenchPlan could also apply quite well to the Condobolin district.)

FarWestWorm

FarWestWorm encompasses the Rural Lands Protection Boards of Milparinka, Wanaaring, Bourke, Brewarrina west of the Culgoa and Bogan

rivers, Broken Hill, Wilcannia, Cobar, Wentworth and parts of Balranald and Hillston west of the Lachlan.

However, if your property is near the boundary of either DrenchPlan or WormKill regions, then in some years a worm control program similar to these will be necessary.

Get professional advice when tailoring a worm control program for your property: contact your local veterinarian or other professional adviser, Rural Lands Protection Board, or NSW Department of Primary Industries.

The WestWorm and FarWestWorm programs are based on monitoring of worm burdens and, when necessary, the use of effective drenches.

WestWorm (northwest plains)

An effective broad-spectrum drench is given in October–November to young sheep, less than 18 months old.

In addition, all sheep receive a closantel drench in October–November in the Moree and Narrabri districts each year. If *Haemonchus* (barber's pole worm) appears in the September–October WormTest, closantel is also given in the Brewarrina, Walgett, Coonamble and Nyngan districts.

Moxidectin (Cydectin®), because of its sustained activity against susceptible barber's pole worm, can be an alternative to closantel. If used, a separate broad-spectrum drench for young sheep will not be necessary.

Where weaning does not coincide with the October–November drench, the need for a weaning drench is determined by a WormTest before weaning.

Do a WormTest (worm egg count) 10–14 days after any treatments to check drench efficacy. This is called a DrenchCheck. (Drench resistance is common.)

Perform a WormTest in late February.

If the average faecal worm egg count is above 200 epg, consider drenching. Discuss the results of the WormTest with your adviser.

Table 1. WestWorm program (northwest plains)

Time	Activity
Autumn–Winter	Prepare low worm-risk paddocks for lambing and weaning
September–October	WormTest ewes and lambs Drench resistance test every 2–3 years; regular DrenchChecks in between.
October–November	Sheep including weaners <18 months old: effective broad-spectrum drench; move to low worm-risk/good feed quality pasture. Additional barber's pole worm control: o Narrabri/Moree districts: closantel or other suitable drench to all sheep for barber's pole worm control in particular. o Brewarrina, Walgett, Coonamble and Nyngan districts: as above, but only when barber's pole worm is present in September WormTest.
Weaning at other times	WormTest first.
Late February	WormTest
Additional drenches	On basis of WormTests, condition of sheep and seasonal conditions.

FarWestWorm (western plains)

Drenching is not needed except in response to rainfall. Since rainfall is irregular and infrequent, drenching at set times of the year is of no value. The need to drench is assessed by monitoring egg counts using WormTest with identification of worm types. Do this 6–7 weeks after significant rainfall, and with additional rain over the following month. When conditions are likely to cause increasing worm burdens, local veterinary and other officers will publicise the need to carry out WormTests.

Table 2. FarWestWorm (western plains)

Time	Activity
Significant rain with follow-up rain; management events.	No routine drenching. Check for need to drench by WormTesting before management events (e.g. yarding for shearing) and also 6–7 weeks after significant rainfall with follow-up rain in the succeeding month.

Include IPM

In both WestWorm and FarWestWorm programs, include integrated parasite management (IPM) practices:

- the effective use of drenches
- grazing management
- flock management, including early weaning. (It may be difficult to wean early in pastoral zones.)
- breeding sheep more resistant to worms
- nutrition
- fine-tuning based on regular worm egg count monitoring (WormTest) and professional advice.

Property and worm management in western NSW

Worm problems can result from either of the scour worms – small brown stomach worm (*Ostertagia/Teladorsagia*) and black scour worm (*Trichostrongylus*) – or barber's pole worm (*Haemonchus*), or a combination of all types. So, there is a potential for worms to be a problem at any time of the year.

Planning joining time and preparing lambing and weaning paddocks are essential. Aim for a compact joining and subsequent lambing period. This allows for better worm control and better lamb health in general.

Lambing paddocks are the most contaminated paddocks on a property. Worm problems, especially from thin-necked intestinal worm (*Nematodirus*), are worse if the same lambing paddock is used each year.

Where possible, wean and move lambs from lambing paddocks to fresh paddocks. This separates young sheep, which are very susceptible to worms, from an important source of infection – and allows ewes to better recover immunity and condition. If this is not possible, more frequent monitoring of young sheep with WormTests will be needed.

Stubble paddocks can be low worm-risk paddocks, and in fact may be very clean, but provide limited nutrition for weaners. Also, drenching and immediately moving to *very* clean paddocks (very few worms on pasture) can potentially increase selection for drench resistance. Stubble paddocks can be of value for dry sheep, releasing the better paddocks for weaners – or allowing for the preparation of lambing paddocks.

The following is general information on worm control programs throughout the State. Talk to your adviser about specific issues relevant to the WestWorm and FarWestWorm program in your area.

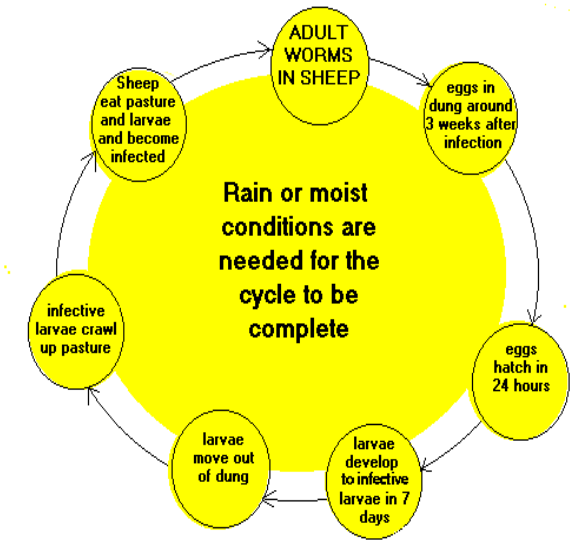
Biology of sheep worms

Without rain and moisture, worm development on the ground cannot be completed and the process is halted, permanently if the conditions are hot and dry for long enough.

The time from infection of sheep to eggs appearing in the dung is around three weeks under optimal conditions. This is longer for some worm species further down the gastrointestinal tract.

Eggs hatch after about 24 to 36 hours if moisture is available. If hot and dry (e.g. several days > 35ºC) eggs die, but in cool conditions they can remain capable of hatching for some months. However, the eggs of barber's pole worm – and even more so, nodule worm – are not particularly tolerant of cold or dry conditions. Barber's pole worm eggs require adequate moisture and warmth within a few days of deposition on pasture, otherwise they will die.

Figure 1. Sheep roundworm life cycle



The eggs of black scour worm, and more particularly small brown stomach worm, are more tolerant of cold or dry conditions than barber's pole worm eggs. The eggs of thin-necked intestinal worm are particularly tolerant of dry conditions, and can hatch some months later with drought-breaking rains.

After eggs hatch, larvae take around a week to develop into an infective (L3) stage. Any larvae eaten before this do not infect sheep. Although infective (L3) larvae cannot feed they can survive for several months during winter. The death rate increases as the weather becomes warmer because more of their limited energy reserves are used. However in wet areas (e.g. bore drains, soaks, and creeks) larvae can survive for several weeks or months if protected by green pasture during warm to hot weather.

The survivability of the larvae of the three main sheep worms – barber's pole worm, black scour worm and small brown stomach worm – are similar. Contrary to popular belief, the larvae of barber's pole worm can survive the frosts typically experienced in Australian winters.

Green pasture should always be considered as capable of being a source of infection even in summer in the western plains.

Contamination of an area with infective larvae depends on the concentration of stock and the numbers of egg being dropped in the dung. If sheep are widely dispersed then worms are less likely to be a problem than when sheep are concentrating on a smaller moist area. However, a series of good seasons in any region can lead to a build up of worm populations and increase the potential for a worm problem.

Black scour worm and small brown stomach worm females lay around 500 to 1,000 eggs per day, whereas a barber's pole worm female can lay up to 10,000 eggs per day. Barber's pole has the potential to increase its numbers very rapidly in the right conditions, which can be catastrophic as it is a blood sucker and can cause significant damage in a short time.

In drier plains areas in particular, thin-necked intestinal worms can cause scouring and weight loss in young sheep under certain conditions. Typically this occurs in weaners grazing short green feed following storms, which allows for a mass hatching of the very resistant eggs deposited on pasture over the preceding months.

Tapeworm, lungworm and liver fluke (*Fasciola hepatica*), unlike the generally more important sheep worms, have a more complex or 'indirect' life cycle. Tapeworm, although easily visible, is rarely a problem in sheep. Liver fluke is mainly a problem – potentially quite a significant problem – in localities in the tablelands and nearby areas, and possibly irrigation areas. Lungworm is rarely a problem and then usually only in stressed sheep.

Host immunity can be a major obstacle for worms, as well as the environmental factors outlined above. Immunity of sheep depends on genetics and other factors, notably nutrition. Host immunity can significantly reduce the numbers of incoming infective larvae that are able to establish. A proportion of those that do establish may be damaged by host immune responses so the worms die and are expelled sooner, or are less able to reproduce.

Table 3. Worms: Who's Who

Worms	Common name	Length of adult worms; location; appearance
Round Worms (Nematodes)		
Haemonchus contortus	Barber's pole worm	10–30 mm; abomasum; red and white 'barbers pole' appearance of females.
Trichostrongylus	Black scour worm	4–7 mm; small intestine.
Trichostrongylus axei	Stomach hair worm	3–4 mm; abomasum; much smaller than *Ostertagia*, difficult to see.
Ostertagia (Teladorsagia)	Small brown stomach worm	6–10 mm; abomasum; appear in clumps.
Nematodirus	Thin-necked intestinal worm	10–23 mm; small intestine; worms visible as tangled red mass.
Chabertia	Large mouthed bowel worm	14–20 mm; colon; stout greyish–white worm.
Oesophago-stomum venulosum	Large bowel worm	11–24 mm; caecum; stout white worm, head not hooked.
Oesophago-stomum columbianum	Nodule worm	12–21 mm; colon; stout white worm, head hooked.
Dictyocaulus	Large lung worm	30–100 mm; lungs.
Muellerius	Small lung worm	12–22 mm; lungs.
Trichuris ovis	Whipworms	40–80mm; caecum.
Trematodes (Flukes)		
Fasciola hepatica	Liver fluke	20–30 mm; liver; some adults in bile ducts.
Paramphistomes	Stomach or conical flukes	5–12 mm; rumen, reticulum (immatures in small intestine)
Cestodes (Flatworms)		
e.g. *Moniezia spp*	Tapeworms	1–6 m; small intestine.

Integrated parasite management

Right drench at the right time

Many producers do not know what the drench options for their property are as they have not recently tested the efficacy of their drenches. It is essential that you find out the right drenches for your property. Each property has a different resistance profile.

Test drench efficiency at 2–3 year intervals or if there is any evidence of drench failure or reduced efficacy. The method of testing is the 'faecal egg count reduction test' (FECRT) also known as 'DrenchTest'.

In addition, perform a DrenchCheck periodically. In its simplest form, this entails doing a WormTest 10–14 days (in the case of short-acting drenches) after you drench a mob of sheep. While not as informative as a full DrenchTest, DrenchCheck is nevertheless a valuable tool.

Low worm-risk pastures

Low worm-risk pastures have moderate numbers of infective larvae. At the very least, they are pastures that have not recently been grazed by young sheep (sheep less than 18 months old). The length of time for which a paddock should NOT be grazed by susceptible stock before it is considered safe to use for weaners will vary from area to area and season to season. Grazing beforehand with cattle can also create low-risk pastures for lambing ewes and young sheep. In NSW tablelands areas for example, the required period of grazing by cattle is roughly 2–3 months or more in summer, and double that in cooler months.

Even cleaner are those pastures that have been cropped, hay paddock regrowth, forage crops, and bush fire aftermath, and have not been subsequently grazed.

Preparation of low worm-risk pastures for weaners is a very important part of effective worm control.

As to timing of drenches, be guided by the program for your area, local expert advice and results of periodic WormTests.

Grazing management

The first general rule is to keep weaners off lambing paddocks as these are likely to be the 'wormiest' paddocks on the property after weaning. Young sheep are more susceptible to worms and should be periodically moved to low worm-risk paddocks. Plan to prepare low worm-risk pastures for weaners. Low worm-risk paddocks should be prepared for lambing ewes also, as these sheep temporarily lose their resistance to worms around lambing.

See panel on low worm-risk pastures.

On the matter of grazing management, sheep grazing close to the ground may well pick up more worms, as most of the infective larvae on pasture are found within 100mm of the ground.

Grazing management vs resistance management

Sometimes there can be a conflict between grazing management and resistance management, specifically when sheep are drenched and moved immediately to another paddock. At one extreme, the new paddock can be heavily contaminated with worm larvae or, at the other extreme, a very clean paddock, with very few larvae. In between these two extremes is the low-worm risk paddock. Very clean paddocks would include previously ungrazed cereal stubble and hay aftermath, and pasture that has been spelled or grazed by cattle for a long period.

Drenching and moving sheep immediately to a contaminated paddock will give poorer worm control, because sheep will be rapidly reinfected, but will tend to produce less selection for resistant worms, as resistant worms left in the sheep post-drenching will be swamped by large numbers of worms, including drench-susceptible worms, on pasture.

Drenching sheep and moving immediately to a very clean paddock will have the opposite effects: excellent worm control, but also with greater selection for drench resistance.

Moving to low-risk pasture is a middle of the road approach, aiming to balance the objectives of worm control and resistance management. Selection for resistance can be lessened further by not moving sheep immediately after drenching.

Immunity to worms

Healthy well-fed sheep exposed to worm burdens build up some immunity to worms over the first 9 to 12 months of life. Consequently adult dry sheep are less susceptible to worms. However, there is a peri-parturient relaxation of immunity in ewes during late pregnancy and early lactation, resulting in more worm eggs being passed onto pasture. This becomes an important source of infection for lambs. This temporary loss of immunity is even more marked in nutritionally stressed ewes, which can have dire consequences for the ewes as well as the lambs.

WormTest – monitoring for worms

WormTest kits are available from Rural Lands Protection Boards, rural merchandisers, NSW Department of Primary Industries and some veterinarians and private laboratories.

Dung sample collection: hold the mob to be monitored - usually weaners are best - in an area such as the corner of a paddock for 10 minutes and then let them drift away quietly. Fresh, clean dung samples (avoid soil) can then be collected from the ground. Ten samples from separate sheep are required and sufficient dung to fill each bottle in the WormTest kit should be collected. Fill out the accompanying form and post to the laboratory within 24 hours of collection. Keep samples cool but do not refrigerate. It may be necessary to sample more than one mob.

Worm egg count results should be available in 1-2 days, but identification of worm types (larval culture and differentiation) will take up to 2 weeks so it is important to take this time delay into consideration when planning to monitor.

All sheep should be considered to be susceptible to *Haemonchus* (barber's pole worm) because immunity to this worm is short-lived.

'Resistance' and 'resilience' are two terms sometimes used when immunity is discussed. The former refers to the ability of the host to resist infection in the first place, whereas resilience refers to the host animal's ability to remain productive despite the worm burden it may have.

Nutrition and immunity

Well nourished sheep have better immunity or resistance to worms than poorly nourished sheep. Well fed sheep are also much better at withstanding the effects of worm burdens – they are more resilient – than sheep that are less well fed. These beneficial effects of good nutrition apply particularly to young sheep, and also to ewes pre-lambing. Weaners that grow well develop immunity to worms and other infections much earlier than poor weaners.

Strategic supplementation, particularly with protein supplements, can have a marked positive effect on immunity and worm control.

Resistant sheep

When buying rams, make use of information on their genetic resistance to worms. Consider rams that are not only productive, but also have a favourable breeding value for WEC (faecal worm egg count.) Improving the genetics of your flock with respect to host-resistance to worms requires plenty of lead time. It takes up to 10 years of using resistant rams to have a marked effect on flock immunity overall.

Flock management

Compact lambing

Aim for a tight joining (6 weeks) and lambing using fit and fertile rams and adequately nourished ewes. A prolonged lambing results in wormier lambs. The lambing paddock can become quite wormy due to the temporary relaxation of ewes' resistance to worms at and after lambing. The longer lambs are on the lambing paddock, the greater the uptake of worms.

Wean early

Early weaning may not be possible on western division properties, but weaning early, at 12–14 weeks from the start of lambing (assuming a 6-week joining), has some distinct advantages. It optimises nutrition for weaners, reduces exposure to worms from contaminated lambing paddocks, and enables ewes to recover body condition and their immunity to worms. Lambs may require drenching at weaning. If in doubt, WormTest.

Flock structure

Flock structure has a big impact on worm control. If a large proportion is young sheep and breeding ewes, then worm control becomes more of a challenge, especially on sheep-only properties. Adult dry sheep can play an important role in reducing worminess of pastures for younger, more vulnerable animals.

Fine tuning

Regular WormTests and drench resistance testing, coupled with professional advice, can help you to tailor your worm control program to your property.

Seek professional advice from your veterinary adviser, Rural Lands Protection Board or NSW Department of Primary Industries.

Drenches and drench resistance

Effective drenches

'Effective' drenches generally are those that kill 95% or more of the adult and developing worms in the sheep. To put it another way, resistance is generally said to occur when a drench reduces egg counts by less than 95%.

A notable exception is the mid-spectrum organophosphate drench, naphthalophos (Combat®, Rametin®, and Pole Vault®).

Naphthalophos on its own is highly effective against adult barber's pole worm, but only 70–90% effective against small brown stomach worm and black scour worm. This has always been the case and is not due to resistance. However, naphthalophos is usually used in combination with other drenches (typically benzimidazole and/or levamisole drenches), and such combinations usually have good efficacy against all the important sheep roundworms.

Because worms rapidly evolve resistance to anthelmintics, it can no longer be assumed that any drench or drench combination is effective without testing it on the worms in the sheep on your property.

The drenches mainly used by sheep producers are broad-spectrum drenches (and closantel and triclabendazole in certain situations). Most are liquid products to be given orally, some are injectable, and there are also intra-ruminal controlled release capsules (see below).

Broad-spectrum drenches

Broad-spectrum drenches kill all types of susceptible round worms of sheep. However, resistance is very common and it is essential to regularly test the efficacy of drenches used on-farm.

Benzimidazole (BZ) drenches – white drenches

BZ drenches are no longer effective on about 90% of properties. Their efficacy needs to be tested before being used.

Levamisole (LEV) drenches – clear drenches

LEV drenches are no longer effective on about 80% of properties, mostly due to resistance in small brown stomach and black scour worms. Unlike the BZs, the LEV drenches are often still effective against barber's pole worm, although the prevalence of resistance of this worm to levamisole is increasing. The efficacy of LEV drenches needs to be tested before being used.

Macrocyclic lactone (ML) drenches

The newest group of drenches, ML drenches are usually very effective against all susceptible round worms of sheep. One ML, moxidectin, has the added advantage of sustained activity against some worm species. The ML group includes the avermectin and the milbemycin sub-groups. Abamectin and ivermectin are avermectins, and moxidectin is a milbemycin. Resistance to the MLs, especially to the avermectins, which are less potent, is now common. The efficacy of all ML drenches needs to be tested before being used.

Combination drenches

These are a combination of two or more drench types and are generally broad-spectrum in activity. Using unrelated broad-spectrum drenches in combination – when resistance to each active is still rare – is likely to significantly delay the development of resistance compared to using these drenches on their own.

Levamisole plus benzimidazole (LEV + BZ)

Around 60% of properties have resistance to BZ + LEV combination drenches. This combination is usually more effective than either of the two drenches on their own when resistance is present.

Naphthalophos and other OP combinations

These include naphthalophos (Rametin®, Combat®, Pole Vault®) combined with BZ and/or LEV. Naphthalophos can also be mixed with some ML products but, as always, check product labels. These on-farm mixtures are often effective against most roundworms in sheep but their efficacy can vary.

Another organophosphate (OP) product on the market is Colleague®, which is a proprietary combination of pyraclofos and a BZ, albendazole.

MLs combined with other broad-spectrum drenches

These are 'multi-active' combinations, for example ML + BZ + LEV.

Praziquantel and broad-spectrum combinations

Praziquantel is very effective against tapeworms; however, these parasites, although highly visible, are of minimal importance compared to less visible parasites such as scour worms (small brown stomach and black scour worms), and barber's pole worm. Praziquantel is usually marketed in combination with a broad-spectrum active such as LEV, BZ or ML, especially for use in lambs/weaners.

Closantel and BZ

The closantel + BZ combination is effective against susceptible roundworms as well as having sustained activity against susceptible barber's pole worm. Because resistance in roundworms to both components of this combination is common, the efficacy of these products needs to be tested before use. Closantel is also a flukicide.

Triclabendazole combined with broad-spectrum drenches

A number of these combinations are now on the market. Triclabendazole is a highly effective flukicide.

Narrow spectrum drenches

Narrow spectrum drenches generally are only effective against one or two worm species. They include the following.

Naphthalophos

When used alone, this is a mid-spectrum drench with moderate activity against gastrointestinal nematodes (except large bowel worms), but high activity against adult barber's pole worm.

Closantel

This is a narrow spectrum drench with sustained activity against susceptible barber's pole worm, and useful activity against susceptible strains of liver fluke. Resistance of barber's pole worm to closantel is very common in the New England region of NSW.

Triclabendazole

This is a narrow spectrum drench highly effective against mature and immature stages of susceptible strains of liver fluke. Resistance of liver fluke to flukicides (closantel, triclabendazole) has been recorded but is currently considered to be uncommon.

Capsules

Long-acting products such as capsules generally have application only in higher rainfall environments where worm populations can be very high. The following is provided for information.

There are three types of capsule available for use in sheep: BZ, ivermectin, and ivermectin-BZ capsules.

These are similar in that they use the same technology and have a 100 day pay-out. They differ in their effectiveness against resistant worms.

Ivermectin capsules are not highly effective against incoming ivermectin-resistant worms. If ivermectin resistance is present, this type of capsule should not be used as it will accelerate ML resistance.

BZ capsules will have little effect against BZ-resistant worms present in the sheep at the time of capsule administration, but often retain useful activity against incoming BZ-resistant larvae. It is important to use an appropriate 'primer' drench or combination of drenches when giving BZ capsules in order to remove BZ-resistant worms already present in the sheep.

So, BZ capsules may still be useful, even when BZ resistance is present. For example, they may be an option for barber's pole worm control on many farms where this parasite is a significant problem. However, seek professional advice tailored to your property.

Many advisers apply certain stipulations to usage of ivermectin capsules. Some of the general conditions apply to BZ capsules also.

1. The producer clearly understands the technology, and has a management system to make best use of the capsule.

2. High pasture contamination is a problem.

3. In the case of ivermectin capsules, testing shows there is no evidence of ML resistance on the property. (Depending on the region, ML resistance is now believed to be present on 10–70% of Australian sheep farms.)

4. Use of the ivermectin capsule does not result in total ML usage on the property exceeding 1/3 of all drench usage on the property for that season.

5. The next drench following this sustained action ML should be an effective short-acting non-ML product.

6. In addition, during the payout period of a capsule:

- A WormTest should be done between 30 and 50 days after the capsule is administered to check efficacy.
- If worm eggs are present, treat with a 'tail-cutter' drench: naphthalophos and levamisole and/or BZ 90 days after the capsule was given. (High efficacy of these drench combinations against the worm species present is assumed.)
- Whenever eggs are present during the capsule payout period, remedial action needs to be taken. For example, the paddock could next be grazed by wormy adult stock with a view to diluting resistant worms surviving the capsule.

Similar approaches to those outlined above (point 6) should be taken with other long-acting products (See 'Make drenches count', page 11).

7. If no worm eggs are present during the capsule payout period, take advantage of the low worm-risk status of the prepared pastures to the fullest.

Registered drenches for sheep

For a list of drenches registered for sheep and goats, see Primefact 152, *Registered drenches for sheep worms at* http://www.dpi.nsw.gov.au/agriculture/livestock/sheep/health/internal/registered-drenches-sheep-worms

Causes of drench resistance

Every time a chemical control agent is used against a genetically diverse population of pests – be they lice, flies, bacteria, weeds or worms – 'selection pressure' is applied. This selection is for the small number of pest individuals who have the genetic

make up to resist the pesticide. In no particular order, there are three major factors influencing how fast drench resistance develops in populations of sheep worms.

Frequency of treatment and exposure to drench

The more a worm population is exposed to a drench, the faster resistance develops. In addition to frequent drench usage, another way to increase exposure is the use of long-acting products. However, this can be a little complicated. For example, use of long-acting products may allow less frequent use of drenches. Potency of a drench is another factor, with more potent drenches killing more resistant worms and so selecting less for resistance.

As a generalisation, the better the worm control you get using a drench, the greater the potential selection for resistance to that drench.
Frequent use of MLs – for barber's pole worm control – may be a cause of the high prevalence (70% of farms) of ivermectin-resistant barber's pole worm in the New England region of NSW.

Under-dosing

Under-dosing often means that more resistant worms survive, whereas most susceptible worms are killed. This results in relatively more resistance genes being passed on to the next generation of worms.

Environment ('refugia')

In dry environments, or dry years, or on very clean paddocks, there are very few worms 'in refugia' i.e. those worms, mostly worms on pasture, which escape exposure to drench and thus selection for drench resistance.

Under tough environmental conditions, or when pastures are very clean for other reasons, most of a property's worm population is inside the sheep and drenching screens a large proportion of the worm population for resistance genes.

The 'environment' or 'refugia' factor perhaps explains why resistance to the ML (mectin) drenches has developed so rapidly in Western Australia. Even though sheep are only drenched once or twice a year in this region, it was done at the start of their hot, dry summer, and sheep were moved onto cereal stubbles, where few worms are in refugia. Most of the next generation of worms were the progeny of resistant worms that survived the last drench.

The Western Australians have moved towards increasing the number of worms in refugia by leaving some sheep un-drenched when a mob is treated or avoiding drenching some classes of sheep, such as dry adult sheep with low worm counts.

The environment factor probably is very important also in long dry spells or droughts. It's likely that drenching sheep unnecessarily in a drought selects a lot more for resistance than drenching in a good season.

Managing drench resistance

The following practices are regarded as high risk in relation to selection for drench resistance, and should be minimised:

- unnecessary treatment of sheep, especially adults
- moving newly drenched animals to very clean pasture
- failure to effectively quarantine drench bought-in animals
- treating ewes pre-lambing with long-acting anthelmintics
- unknowingly using ineffective drenches.

Drench resistance – how common is it?

Resistance to sheep drenches is widespread and 90% or more of farms have a resistance problem to some degree. Table 4 is an overview of the current resistance situation, with particular reference to NSW.

Table 4. Prevalence of drench resistance

Drench or drench group	Prevalence of resistance*
Benzimidazole (BZ) or White drenches	Approx. 90% of properties.
Levamisole (LEV) or Clear drenches	Approx. 80% of properties.
Combination (BZ + LEV) drenches	Approx. 60% of properties.
Macrocyclic lactone (ML) drenches	Becoming more common, with approx. 10–70% of Australian farms (depending on region) affected. Very common in WA (in *Ostertagia*) and northern NSW/south eastern Queensland (in *Haemonchus*), less common elsewhere.
Naphthalophos	Two confirmed cases only reported in Australia.
Closantel	Resistance in *Haemonchus* is common (60–80% of farms) in northern NSW & S.E. Queensland. Some strains are also ML-resistant. Small number of resistant strains of liver fluke in Australia.
Triclabendazole	Small number of resistant strains of liver fluke in Australia.

*Drench efficacy < 95%

Combinations of unrelated drenches

In order to slow develop of resistance, it is generally better to use two or more unrelated but highly effective drenches in combination than to use them separately and on different occasions. To maximise this benefit, resistance to each of the active ingredients must be rare, and the individual drenches should have similar spectra and length of activity.

One occasion where using a combination may be ill-advised is when moving newly treated animals to very clean pasture. In this case, if 'super-resistant' worms do survive the combination drench, there will be very few susceptible worms in refugia (on pasture) to dilute the progeny of the resistant worms in the treated sheep.

Quarantine drenching (don't import resistance)

There are two ways to get resistant worms:

- breeding your own, and
- importing someone else's.

Clean out introduced sheep with a quarantine drench. Optimally this should be a combination of four unrelated drenches, for example ML+BZ+LEV+naphthalophos. The ML of choice is moxidectin, followed by abamectin, being the two most potent MLs.

With proprietary combination drenches on the market – and the ability to mix some drenches on-farm (check product labels) – this need not be onerous.

Hold the sheep for at least 24 hours after drenching – time for worm eggs to be passed – before release onto pasture, preferably not clean pasture. (If any resistant worms survive, it is desirable to have their progeny diluted by plenty of drench-susceptible worms already on the pasture.)

Do a WormTest 10–14 days after treatment to check the effectiveness of the quarantine drench.

These recommendations pertain to roundworms. Farmers will also need to consider whether they need to treat imported sheep for liver fluke. Although still uncommon, there are several cases of resistance to currently available fluke drenches.

Testing drenches

Resistance testing aims to determine the activity of various drenches against worms in the sheep on your property. Results from other properties or neighbours could be quite different. Tests ideally should be carried out every two to three years. The aim is to identify the most effective drenches on your property, resulting in better worm control and better management of drench resistance. Most properties will have resistance to one or more of the drenches available.

DrenchTest

This is an on-farm test where groups of 15 sheep in a mob are treated with the drenches to be tested. Individual dung samples are taken from the sheep in the treated groups and one untreated control group 10 to 14 days after treatment. The samples are then forwarded to the laboratory for egg counting and worm type identification. The total time for a result is around 25 days. The cost is variable depending on the number of groups treated, so check with your lab.

DrenchCheck (post-drench WormTest)

This involves doing a WormTest (egg count + culture) 10–14 days (in the case of short-acting drenches) after drenching a mob of sheep. Although not as informative as a full DrenchTest, this simple approach nevertheless is useful and should be done periodically. To improve the accuracy still more, do a WormTest on the day of drenching as well. In the case of long-acting products, a further WormTest, additional to the one 10–14 days post-treatment, is advised.

DrenchRite™

This test is no longer routinely available (since 2006.) It was a laboratory-based test known as an egg development assay, and tested the effectiveness of BZ, LEV, BZ+LEV and, in some instances, ML drenches. As such it had limitations. Unlike DrenchTest, other drenches/combinations or different dose rates could not be tested in the DrenchRite assay.

Make drenches count

Make sure each sheep gets the right dose

Double check the dose rate, and regularly check and service your drench guns. Check sheep weights and drench to the top weights in the mob. Draft sheep into different weight range groups if necessary. Follow the label.

Make sure the selected drench is effective

Regularly test drenches.

Reduce feed before drenching

For BZ, ML and closantel drenches, reducing feed (especially green feed) but not water 24 hours before drenching may make the drench more effective. (This does not work for LEV drenches.) To maximise the effect, also withhold green feed for up to 6 hours after the drench. Do not restrict feed or water in heavily pregnant, stressed or poor

sheep. Do not restrict feed or water before or after using organophosphate drenches.

Place drench gun tip over the tongue

This ensures that more of the drench will go into the first stomach (rumen or paunch), thus extending drench availability. Drench that goes into the fourth stomach (abomasum) is less effective. This is more likely to happen when drench is deposited in the front of the mouth. Take care not to direct drench into the windpipe and lungs, especially with organophosphate drenches.

'Tail-cutter' drenches

Tail-cutter or exit drenches are sometimes used after treatment with long-acting anthelmintics, when the blood levels of that product is tailing off. The purpose is to remove resistance worms that may infect sheep during the tail of a long-acting product.

Tail-cutter drenches are typically short-acting and often are combinations of drenches to ensure high efficacy against resistant worms.

Combine with non-drench strategies

Use integrated worm control, including nutrition, grazing management, and use of worm-resistant rams.

Annual drench rotation

Annually rotating from one effective broad-spectrum drench group to another has long been promoted as a good worm control practice. More recently it has been argued on the basis of computer modelling studies that rotation makes little difference to how many uses one can get from a drench before resistance renders it useless.

However, even if rotation does not substantially increase the number of uses you can get from a drench, it will increase the number of years a drench remains effective. So, rotation is still recommended, especially if combinations are not routinely used, but it is essential that you use drenches tested and found to be effective on your farm.

Flexibility with drench rotation may be required in some areas, for example where barber's pole worm is a major challenge.

Rapid rotation may be employed e.g. after a ML drench, the next drench is a non-ML drench.

The mixed method is another option. This involves restricting the use of ML drenches each year to 30% of the property grazed by the sheep that particularly need an ML (e.g. young sheep). The aim is then to use the ML on a different 30% of the property in the following year.

Rotation using combinations is another approach. For example, rotating from a non-ML combination to one that does contain an ML.

For many, annual rotation is a good option, especially in DrenchPlan areas where barber's pole worm is not usually a major problem.

Goats

Relatively few sheep drenches are also registered for use in goats, although an abamectin-based drench for goats (Caprimec®) was released in 2007. In NSW, a product must be used according to the label unless you have received written instructions from a veterinarian to use it in another way. This applies to the use of sheep products for goats. Goats require special care in the use of anthelmintics as they metabolise drenches slightly differently. The incorrect and frequent use of sheep products off-label may have contributed to significant resistance problems with goat parasites, especially barber's pole worm. Note that goats share many parasites with sheep, and also some parasites with cattle.

An off-label permit (Per 9864, expires 1 April 2009) has been issued by the Australian Pesticides and Veterinary Medicines Authority for the use of trichlorfon (Neguvon™ (Bayer)) for use in goats for the control of barber's pole worm. Producers will need to obtain a copy of this permit from the APVMA before using trichlorfon for goats.

Further information

Various Primefacts on internal parasites are available from the NSW Department of Primary Industries web site:
www.dpi.nsw.gov.au/primefacts

WormBoss: www.wormboss.com.au

Acknowledgments

This Primefact is based on Agnote DAI/45 *WestWorm and FarWestWorm* by Robert Wroth and Stephen Love. Robert Wroth was formerly District Veterinarian, Coonamble in the late 1990s.

FarWestWorm from the outset has been a team effort, with input from NSW DPI, Rural Lands Protection Board veterinarians, CSIRO, and veterinarians and others in the private and university sectors.

WestWorm is very similar to Narrabri Worm, which was developed by Shaun Slattery, District Veterinarian, Narrabri. Both these programs are versions of an early version of WormKill, modified to suit the lower rainfall areas of Narrabri and nearby districts.

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Check for updates of this Primefact at:
www.dpi.nsw.gov.au/primefacts

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