NSW DPI
primefacts
PROFITABLE & SUSTAINABLE PRIMARY INDUSTRIES www.dpi.nsw.gov.au
SEPTEMBER 2005 PRIMEFACT 14

DrenchPlan 2005

Stephen Love
Veterinarian/State Coordinator-internal parasites, Armidale

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, (Far)WestWorm 1998).

Figure 1. Sheep worm programs for NSW

The programs developed for New South Wales (see map, page 1) 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, breeding resistant sheep, and other factors.

Drenchplan

DrenchPlan is the sheep worm management for the following areas in New South Wales:

- Central West – Dubbo, southern portions of Mudgee-Merriwa and Hunter RLPB districts, Molong, Central Tablelands and Forbes RLPB districts
- Southern Tablelands – Young, Goulburn, Yass, Braidwood and Gundagai districts
- Monaro – Cooma and Bombala RLPB districts
- South West Slopes and Irrigation Areas – Wagga Wagga, Hume, Narrandera, Murray, Hay and Riverina RLPB districts.

DrenchPlan – an integrated worm management program

DrenchPlan is an "integrated worm management program" combining

- the effective use of drenches
- grazing management
- flock management, including "early" weaning
- breeding sheep more resistant to worms
- nutrition
- "fine-tuning" based on regular worm egg count monitoring (WormTest)

Right drench, right time

All sheep receive one or two **Summer drenches** except

- In dry areas with average annual rainfall 350-500 mm or less. Here the first summer drench - in November or December (when pasture is haying off) - will usually suffice. (Check using WormTest).
- Where sheep have low worm burdens and have been moved to 'low-worm risk' pastures. (Check using WormTest).
- In all areas where a WormTest in February indicates the second summer drench is unnecessary.
- During droughts. Worm burdens are often (but not always!) quite low during droughts. Consider dropping one or both summer drenches, especially in adult sheep in good condition, if egg counts are low (e.g. below 100-200 eggs per gram of faeces) and conditions are dry. Unnecessary drenching during droughts can accelerate the development of drench resistance.

The **Summer drenches** should be effective broad-spectrum drenches:

- The first summer drench is given when pasture is drying off. This is usually in November/December, but no later than mid-December. This is the time of year when drenching will have the greatest overall effect because worm larvae on pasture are dying off more rapidly. Reinfection of sheep therefore is less.
- The second summer drench, if required, is given when it is hot and dry (February). Check first with a WormTest.

The summer broad-spectrum drenches are particularly directed at the most important worms in the DrenchPlan areas - black scour worm, and small brown stomach worm. Thin-necked intestinal worm can occasionally be a problem, especially in young sheep, and with rain after a prolonged dry spell.

Barber's pole worm can be a problem in certain areas and seasons. If so, an option is to use closantel with either or both of the summer drenches and/or in autumn depending on local conditions and WormTest results. Check that closantel is still effective on your property. Do a DrenchTest, or at least do a WormTest after using closantel. (There should be no barber's pole worm eggs in the faeces of sheep 6 weeks after treatment with closantel).

Additional Drenches

Pre-lambing drench. If indicated by WormTest results (for example >200 eggs per gram (epg) of faeces), drench ewes with an effective broad-spectrum drench. This can be done when vaccinating ewes 2-3 weeks pre-lambing for diseases such as pulpy kidney, tetanus, and cheesy gland. Remember that healthy dry adult sheep often do not require broad-spectrum drenches apart from the summer drench(es). Don't guess, WormTest.

Lambs should be drenched at

- **Weaning**, 12-14 weeks after the start of lambing. For Spring-drop lambs, this may coincide with the first summer drench. After drenching, they should be moved to a "low-worm risk" pasture.
- **A second "drench and move"** may also be required at 20 weeks after lambing. Likewise autumn lambs should be drenched at weaning and again -depending on WormTest results - at 20 weeks.

"Early" weaning - 12-14 weeks after the start of lambing - is an important part of worm control. It separates the two classes of sheep most susceptible to worms, and it also means that lambs are not competing with their mothers for nutrition. The ewes also benefit by returning more

quickly to optimal joining weights (resulting in more lambs the following season).

Lambs usually do **not** require drenching at **lamb marking**, unless the ewes and the lambing paddock are particularly wormy. If in doubt, check with a WormTest on ewe and lambs just before marking. (Collect clean, fresh dung samples from the paddock).

Weaners may need **extra drenches** in April and July. Check with a WormTest.

Liver fluke

If liver fluke is a problem one to three fluke drenches per year may be required. The most important of these is the April treatment. At this time, a flukicide effective against all stages of liver fluke, including early immatures (<6-weeks old) is recommended (a triclabendazole-based product). If an August fluke drench is required, rotate to a non-triclabendazole flukicide. WormTest or blood tests (liver fluke ELISA) can be used to check for liver fluke. Seek veterinary advice.

Putting it all together

Following is an example of how DrenchPlan may be applied. Fine-tune the plan to suit your property, and seasonal conditions. Particularly avoid over-drenching in droughts. Do regular WormTests and get professional advice.

				Effective Broad-spectrum drench[1]		Added Worm Control (All sheep)[2] (WormTest first)	
Date	Comments	Grazing management[3]	Extra WormTest[4]	Adults and Hoggets	Lambs/ Weaners	Barber's pole worm	Liver fluke
July		Preparation of 1st LOW WORM-RISK pastures for weaners	All classes of sheep incl. ewes pre-lambing				
September							Closantel or triclabendazole. (Worm Test first)
Weaning 12-14 weeks after start of lambing	Drench and move young sheep at weaning, and again (check first with WormTest) at 20 weeks of age	Preparation of 2nd LOW WORM-RISK pasture for weaners is under way			✓		
November-mid December First "summer" drench	Pastures are haying off			✓[5] (Worm Test first)	✓ (Worm Test first)		
February Second "summer" drench	Hot, dry This drench may be unnecessary in drier areas (350-500 mm rainfall) and seasons.		All classes of sheep	✓ (Worm Test first)	✓ (Worm Test first)		Closantel or triclabendazole (Worm Test first)
April			Young sheep				Triclabendazole (Worm Test first)

[1] Effective Broad-spectrum drench. A drench or combination of drenches that is >95% effective.

[2] Added Worm Control (All sheep). Extra drenches for barber's pole worm and /or liver fluke may be required in some areas or seasons. Closantel is one option for added barber's pole worm control, and has the added advantage of controlling late immature and older liver fluke as well.

[3] Grazing management. For young sheep in particular, aim to move to 'worm-safe' pastures. At least avoid grazing young sheep on pastures likely to be 'wormy' eg lambing paddocks in most cases or pasture previously grazed by young sheep, goats or 'wormy' adult sheep.

[4] Extra WormTest. Depending on seasonal conditions, extra monitoring of egg counts may be required especially in susceptible stock (young sheep, lactating sheep).

[5] WormTest +/-Drench. These are times when a drench may be required. Timing may change depending on the season. Optimally a WormTest should be done before drenching. Also consider a WormTest after drenching (10 days after for short-acting drenches) from time to time to monitor efficacy of drench.

Rather than automatically doing the second summer drench, do a WormTest first.

In prolonged dry spells or droughts, it is particularly important to do a WormTest before drenching. It is believed that drench resistance develops faster in droughts.

Sheep roundworm life cycle diagram

General information

Following is general information which applies to worm control in sheep and other livestock in most areas.

Biology of sheep worms

Following are some basics of worm biology.

(See life cycle diagram)

Important points

- 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 (eg several days > 35 degrees C) eggs die, but in cool conditions they can remain capable of hatching for some months. The eggs of barber's pole worm – and more so, nodule worm –are not particularly tolerant of cold or dry conditions. Barber's pole worm eggs require adequate moisture within a few days of deposition on pasture, otherwise they will die.
- 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 (eg bore drains, soaks, 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 winter in Australia.

- 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 very damaging even with a small number of worms.
- 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 allow 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" lifecycle. 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. 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.

Worms: Who's Who	
Round Worms(Nematodes)	
Haemonchus	Barber's pole worm
Trichostrongylus	Black scour worm
Ostertagia (Teladorsagia)	Small brown stomach worm
Nematodirus	Thin-necked intestinal worm
Chabertia	Large mouth bowel worm
Oesophagostomum venulosum	Large bowel worm
Oesophagostomum columbianum	Nodule worm
Dictyocaulus/Muellerius	Lung worms
Trichuris ovis	Whipworms
Trematodes (Flukes)	
Fasciola hepatica	Liver fluke
Paramphistomes	Stomach or conical flukes
Flat Worms (Cestodes)	
eg *Moniezia spp*	Tapeworms

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'.

It is recommended to test 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, consider doing a '**DrenchCheck**' periodically. In its simplest form, this entails doing a WormTest 7-14 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 relatively few 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 worm-safe 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 6 months or more in cooler months. Other low worm-risk pastures are those that have been cropped, hay paddock regrowth, forage crops, and bush fire aftermath.

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
- 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 moved to the cleanest available ('low-worm risk') paddocks after drenching. 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 previous 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.

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 "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.

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.

WormTest - Monitoring for Worms

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

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 (avoid soil) dung samples 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.

Complete results (worm egg counts plus identification of worm types) will take up to 2 weeks so it is important to take this time delay into consideration when planning to monitor.

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. 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 FEC (faecal egg count). Improving the genetics of your flock with respect to host-resistance to worms requires plenty of lead time. It takes perhaps 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 spread out, 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** - at 12-14 weeks from the start of lambing (assuming a 6 week joining). This 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 12-14 weeks even if not weaned at this time as recommended. In some cases where early weaning is not practised, ewes also may need an extra drench, because of greater exposure to contaminated pasture. 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.

Fine tuning

Regular WormTests and drench resistance testing, coupled with professional advice, can help you to fine-tune DrenchPlan to fit the particular characteristics of your property.

These are general recommendations. 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. Or, to put it another way, resistance is generally said to occur when a drench is less than 95% effective.

A notable exception is the mid-spectrum organophosphate, naphthalophos (Combat®, Rametin®). 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 kill all types of susceptible round worms of sheep.

- Benzimidazole (BZ) drenches - "White" drenches. These drenches are no longer effective on around 90% of properties. Their efficacy needs to be tested before being used.
- Levamisole (LEV) Drenches - "Clear" drenches. These drenches are no longer effective on around 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 appears to be increasing. The efficacy of LEV drenches needs to be tested before being used.
- Macrocyclic lactone (ML) drenches - The newest group of drenches, these are very effective against all round worms of sheep. This 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, has become more common in recent years. 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.
  - 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 (Rametin®, Combat®) plus 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.
  - MLs combined with other broad-spectrum drenches. ('Multi-active' combinations). Currently there are two registered: Triton® (ivermectin+LEV+BZ) and Q-Drench® (abamectin+LEV+BZ+closantel). Using unrelated 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.
  - 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 in combination with broad-spectrum drenches. A number of these combinations are now on the market. Triclabendazole is a highly effective flukicide.
- Narrow spectrum drenches generally are only effective against one or two worm species. They include:
  - 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.
  - Triclabendazole. This is a narrow spectrum drench highly effective against mature and immature stages of susceptible strains of liver fluke.

Capsules

There are two types of capsule available for use in sheep: the BZ capsule and the ivermectin capsule. These two 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 the capsules in order to remove resistant worms already present in the sheep.

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

Various advisers (including BF Chick and others) 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. 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 10-60% 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:
    - o A WormTest (egg count monitor) should be done between 30 and 50 days after the capsule is administered to check efficacy. This should be done with BZ capsules also.
    - o If worm eggs are present, treat with 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).
    - o 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.
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.

Drench Resistance

For information on the prevalence of drench resistance, see panel - "Drench resistance - how common is it?"

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 is where things start to get 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.

No-one has all the answers. Keep in mind this generalisation:

"The better the worm control you get using a drench, the greater the potential selection for resistance to that drench."

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.

To put it another way, under these environmental conditions, 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 macrocyclic lactone ('mectin') drenches has developed so rapidly in Western Australia. Even though sheep are only drenched once or twice a year in 'the west', it is done at the start of their typically hot, very dry summer, and onto cereal stubbles, where few worms are 'in refugia'. The Western Australians are experimenting with 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.

Avoid unnecessary drenching. A simple and practical solution is to 'WormTest' - monitor faecal worm egg counts - before drenching. This will help to save your drenches as well as time and dollars.

Drench resistance – how common is it?

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

Drench or Drench Group	Prevalence of Resistance*
Benzimidazole (BZ) or "White" drenches	Approximately 90% of properties
Levamisole (LEV) or "Clear" drenches	Approximately 80% of properties
Combination (BZ + LEV) drenches	Approximately 60% of properties
Macrocyclic lactone (ML) drenches	Becoming more common, with probably 10-60% 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 (Combat®, Rametin®)	One confirmed case 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 (Fasinex®, Flukare®)	Small number of resistant strains of liver fluke in Australia.

*** Drench efficacy < 95%**

Combinations of unrelated drenches

Scientists generally agree that, in order to slow develop of resistance, it is 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.

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.

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 before release onto pasture, preferably not clean pasture. (If any resistant worms survive, you want their progeny to be 'diluted' by lots of 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 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.

DrenchRite™

This may be useful as a first test if you have no information on your drench resistance status.

This is a laboratory test only for testing the effectiveness of BZ, LEV, BZ+LEV and, in some instances, ML drenches. Unlike DrenchTest, other combinations or increased dose rates can not be tested in this assay. DrenchRite™ collection kits with full instructions are available from Rural Lands Protection Boards, rural merchandisers, and NSW Dept of Primary Industries. The test requires a bulk sample of about two cup-fulls of dung collected from around 20 sheep. Results are available within 3 weeks, and only apply to the predominant worm type. (This test may be temporarily unavailable. Ask your laboratory).

Make drenches count

Make sure each sheep gets the right dose. Double check the dose rate, 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.

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 sheep1. Do not restrict feed or water before or after using naphthalophos 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[1], especially with naphthalophos drenches.

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 scientists have 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 no doubt increases the number of years a drench will remain effective. So, rotation is still recommended but it is essential that you know what your drench options are i.e. you have tested the effectiveness of the different drench groups on your farm.

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

Greater flexibility with drench rotation may be required in some areas, for example, where barber's pole worm is a major challenge. Some use 'rapid rotation' i.e. after a ML drench, the next drench is a non-ML drench. Others use a mixed method which 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 (B Chick and others, personal communication).

What about goats?

Relatively few sheep drenches are also registered for use in goats. 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.

[1] "Successful Worm Treatment" Hennessy DR and Ali D. CSIRO pamphlet.

Recently an off-label permit (Per 6304 valid from May 2003 - March 2006) was 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.

For more information, see Agnote DAI76 - Registered drenches for sheep worms.

More information

Some of the topics discussed here are dealt with in greater detail in separate Agnotes. See NSW DPI's website:
www.agric.nsw.gov.au/reader/sheep-internal

Also see WormBoss: www.wormboss.com.au

Always read the label

Users of agricultural (or veterinary) chemical products must always read the label and any Permit before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the Permit by reason of any statement made or not made in this publication.

Acknowledgments

DrenchPlan 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 sector and universities.

This Primefact replaces Agnote DAI-88 *DrenchPlan 2000*.

ISSN 1832-6668

JOB NUMBER 5879

Updates of this Primefact are available at www.dpi.nsw.gov.au/primefacts

Registered Sheep and Goat [G] Drenches - NSW (Source: Infopest. Also see www.apvma.gov.au)

Chemical	Brand Name and Maker	Comment
BENZIMIDAZOLE (BZ) OR "WHITE" DRENCHES (Broad-spectrum)		Resistance occurs on approximately 90 percent of farms
Albendazole	Alben[V][G] Albendazole[W][G] Nemadet[N] Rycoben[NV] Strategik[J] Valbazen[P][G]	BZ susceptible roundworms, lungworms, tapeworms, aids control of adult liver fluke.
Albendazole capsules	Extender[N]	BZ susceptible worms; suppresses establishment of worm larvae up to 100 days
Fenbendazole	Fenbendazole[4] Fenbendazole[W] Fencare[V] Panacur[I]	BZ susceptible roundworms, lungworms, tapeworms.
Mebendazole	Benzicare[V] Mebendazole[W]	
Oxfendazole	Oxazole[D] Oxfen[V] Parafend[NB] Synanthic[C]	
LEVAMISOLE (LEV) / MORANTEL OR "CLEAR" DRENCHES (Broad-spectrum)		Resistance occurs on about 80 percent of farms
Levamisole	Big L[S] Combat Clear [V] Levamisole[4] Levamisole[N] Levamisole[NV] Levamisole[V] Levamisole[W] Nilvax[C] Nilverm[C] Nulev[CT],MRipercol[C] Rycozole[NV]	LEV susceptible roundworms, lungworms
Morantel	Oralject[O]	
MACROCYCLIC LACTONES (Avermectins / Milbemycins) "MLs" (Broad-spectrum)		Resistance now occurs on 10-60 per cent of Australian farms, depending on region
Abamectin	Abamectin[4] Abamectin Baymec[B] Abamectin[GF] Abamectin[W] Combat Abamec[V] Genesis[A] Paramectin[J] Rycomectin[NV] Vetmec[CV] Virbamec[V] Zoomec[F]	ML susceptible roundworms, lungworms, nasal bot, itchmite
Ivermectin	Ecomectin[E] Ivomec[M] Genesis[A] Noromectin[NB] Numectin[N] Oramec[N] Paramax[C] Sheepmec[V] Virbamax[V]	
Ivermectin capsules	Ivomec Maximizer[M]	Capsules: treatment and 100 day control of ML sensitive roundworm, nasal bot, itchmite, ked; reduces dags and blowfly breech strike
Moxidectin	Cydectin[FD] Eweguard/ Weanerguard[FD] Cydectin LA[FD]	ML susceptible roundworms, lungworms, itchmite
ORGANOPHOSPHATES (Mid-spectrum)		
Naphthalophos (NAP)	Combat[V] Rametin[B]	Most roundworms (moderately to highly effective, depending on worm species)

COMBINATION DRENCHES (Broad-spectrum)		
Levamisole + Benzimidazole (LEV + BZ)	Combi[NV] ComboLV[B] Combination[4] Combination[W] Duocare[V] FirstDuoDrench[V] Leviben[NV] Nucombo[N] Rotacare[C] Rotate[NV] Salvo[I] Scanda[C]	BZ or LEV susceptible roundworms; lungworms, tapeworms. Resistance to this combination occurs on approximately 60% of farms.
Ivermectin + LEV + BZ	Triton[M]	
Abamectin + LEV + BZ + closantel	Q-Drench[J]	
Naphthalophos + BZ and/or LEV	Rametin[B] or Combat[V] plus BZ and/ or LEV	This combination may be an effective broad spectrum even if BZ, LEV or ML resistance is present.
Naphthalophos + ML	(Check product labels for directions)	
Closantel + albendazole	Closal[C] Caddy[F]	
Closantel + oxfendazole	Rotafluke[V]	
Closantel + abamectin	Genesis Xtra[A]	
Oxyclosanide + LEV	Nilzan[C]	LEV susceptible roundworms, lungworms, adult liver fluke
Praziquantel + abamectin	First Mectindrench[V]	ML susceptible roundworms, lungworms, tapeworms (heads and segments)
Praziquantel + LEV	FirstDrench[V]	LEV susceptible roundworms, lungworms, tapeworms (heads and segments)
Praziquantel + LEV + fenbendazole	First Duodrench[C]	(LEV + BZ) susceptible roundworms, lungworms, tapeworms (heads and segments)
Praziquantel + moxidectin	Cydectin plus Tape[FD]	
Triclabendazole + abamectin	Flukamec[V]	
Triclabendazole + ivermectin	Paramax-F[C]	
Triclabendazole + moxidectin	Cydectin plus Fluke[FD]	
Triclabendazole + oxfendazole	Flukazole S[V]	
NARROW SPECTRUM DRENCHES		
Closantel	Closantel[4] Closantel[W] Closicare[V] Razar[C] Seponver[P] Sustain[P]	Resistance in barber's pole worm to closantel occurs on 60-80% of farms in N.NSW and SE Qld. There are also several strains of liver fluke resistant to this drug. Effective against susceptible barber's pole worm, including 28 days protection against reinfection, susceptible liver fluke over six weeks old, and nasal bot.
Nitroxynil	Trodax[M]	Liver fluke over 6 weeks old; barber's pole worm.
Praziquantel	Cestocur[B]	Tapeworms (heads and segments)
Triclabendazole	Fasicare[V] Fasinex[NV] Fasinex 50[NV] Flukare [V] Flukex[D]	Susceptible liver fluke including early immatures

Key to Companies: [4]4 Farmers [A]Ancare [B]Bayer [C]Coopers [C]TCaptec [CV]Chemvet [E]Eco Animal Health [F]Farmoz [FD]Fort Dodge [GF]Grow Force [I]Intervet [J]Jurox [M]Meriel [N]Nufarm (now distributed by Merial) [NB]Norbrook
[NV]Novartis (including Youngs), [O]Oralject [P]Pfizer (now distributed by Coopers) [S]Sykes VVirbac [W]WSD

[G] Also registered for use in goats.

This is an abbreviated list. Not all variations on a product – or full trade names – are listed. (Some product versions include minerals, have praziquantel (tape-wormer) added, or are in low volume formulations, for example). Some products that are no longer available but still registered may not be listed (e.g. Thibenzole).

Table Long acting drenches – options

			Protection against reinfection (days) (label claim)		
	Active ingredient	Trade name	Barber's pole worm	Black scour worm	Small brown stomach worm
Oral	moxidectin	Cydectin®	not less than 14[1]	no persistent activity	not less than 14
Injectable	moxidectin	Eweguard®, Weanerguard®[2]	not less than 21	not less than 7	up to 21 days
		Cydectin Long Acting for Sheep	not less than 91	up to 49	not less than 91
Capsule[3]	ivermectin	Ivomec Maximiser®	100 days against susceptible worm populations, but resistance, especially to BZs, is common.		
	albendazole	Extender®			
Closantel[4]-based	closantel	Various brands	28	No effect at any stage, but is effective against liver fluke (adults and immatures)	

1 Cydectin plus Tape, unlike other Cydectin formulations (Cydectin, Cydectin plus Fluke etc), does not have persistent activity against barber's pole worm.

2 Eweguard/Weanerguard also includes a 6-in-1 vaccine (clostridial diseases plus cheesy gland).

3 Capsules: Do a WormTest midway through the capsule payout period and after this period. Unlike ivermectin capsules, albendazole (ABZ, BZ, or 'white') capsules can often be used when resistance is present, but it is important to clean out resistance worms with an effective drench or combination of drenches when capsules are administered.

4 Closantel is a narrow spectrum drench with activity restricted to barbers pole worm, liver fluke and nasal bot. There are also closantel + BZ or ML products on the market.

Activity of drench types

	Round worms						Flat worms	
Drench type	*Haemonchus* (Barber's pole worm)	*Trichostrongylus* (Black scour worm)	*Ostertagia* (Brown stomach worm)	*Nematodirus* (Thin necked Intestinal worm)	*Chabertia* (Large mouth bowel), *Oesophagostomum* (Large bowel worm)	Lung worms	Tape worms	*Fasciola* (Liver fluke)
Broad Spectrum drenches (single active)								
BZ[2]								
LEV								
ML								
Combination drenches								
BZ+LEV								
Ivermectin+ BZ[2]+LEV								
Abamectin+ BZ+LEV+ closantel								
Closantel + BZ[3]								
Triclabendazole + broad-spectrum								
Praziquantel + broad-spectrum								
Naphthalophos + (BZ or LEV or BZ+LEV or ML)								
Narrow spectrum drenches								
Closantel								
Naphthalophos								
Triclabendazole								

Note: The table above outlines activity against susceptible worm populations. Drench resistance may alter the picture markedly. This table is only a guide to spectra of activity; no information on persistency of activity is included. Some drenches may also have activity against other parasites, e.g. itch mite, nasal bot. The most important parasites of sheep in Australia are *Haemonchus*, *Trichostrongylus*, *Ostertagia* and, in some areas, *Fasciola*.

Key (Activity in susceptible worm populations)			
Highly effective	Useful activity	Some activity	Little or no activity

[2] Albendazole aids in the control of adult fluke.
[3] Closantel +oxfendazole has a claim for greater efficacy against liver fluke than closantel+other BZs.